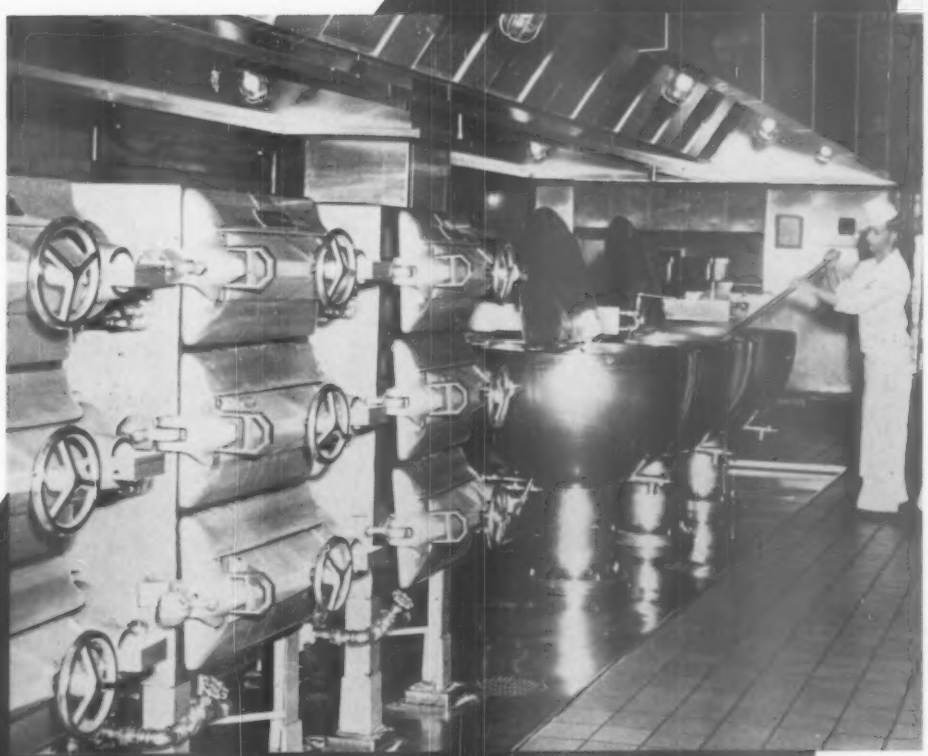
JULY 1961
Vol. , No. 7

FT food technology



Look closely at any successful flavored product. Taste it, compare it. Why is it some flavors have compelling consumer appeal?

IFF flavors sell and resell for two important reasons. They are exclusively designed for your product, your markets—and they are the finest flavors available. IFF flavors have created new product lines, improved established ones and stimulated brand-building sales the world over.

To manufacturers interested in selling abroad, IFF can supply your flavor—uniform in taste—from any of its plants throughout the Free World.

For an inside look at flavors designed to sell your products, contact IFF.

FLAVOR DIVISION

iff

INTERNATIONAL FLAVORS & FRAGRANCES INC.

417 Rosehill Place, Elizabeth 2, N. J.

Leading Creators and Manufacturers in the World of Flavor

ARGENTINA AUSTRIA BELGIUM BRAZIL CANADA ENGLAND FRANCE GERMANY HOLLAND ITALY MEXICO NORWAY SOUTH AFRICA SWEDEN SWITZERLAND U.S.A.

The young lady is demonstrating the clarity of Swift's Superclear Gelatin. The cake, about 2¼ inches thick, is made from a 10% solution.

Gelatin has many properties which can help enhance the appeal and sales potential of other food products.

SWIFT'S GELATINS MAY ANSWER YOUR NEEDS

Gelatin is a versatile food . . . capable of doing many things well. But most important to food processors, gelatin is a concentrated *food protein* of high purity. And, protein is a *business* at Swift. As both a producer and a user of gelatin products, Swift & Company has been a pioneer in the development, production, and application of gelatin to specific uses.

If you use protein colloids . . . or if your process requires any functions noted above—Gelatin, the high purity *food protein*, may be the answer, and SWIFT IS THE *INFORMED* SOURCE.

Swift
GELATINS

106TH YEAR

Write today for details:

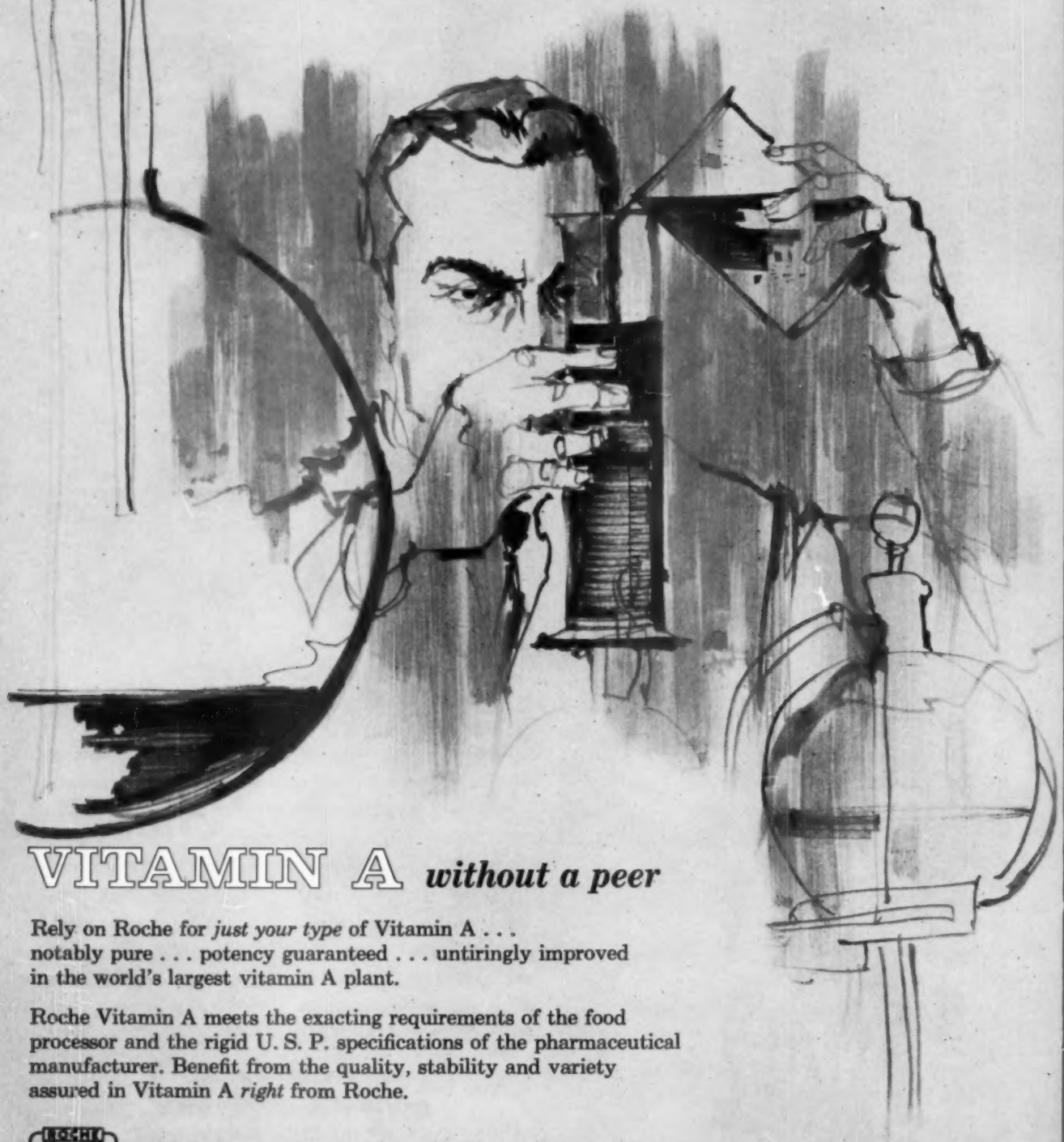
SWIFT & COMPANY,
GELATIN DEPARTMENT

1215 HARRISON AVENUE, KEARNY, NEW JERSEY

To Serve Your Industry Better
with specialized gelatins

GE-57

FROM RESTLESS ROCHE RESEARCH



VITAMIN A *without a peer*

Rely on Roche for *just your type* of Vitamin A . . . notably pure . . . potency guaranteed . . . untiringly improved in the world's largest vitamin A plant.

Roche Vitamin A meets the exacting requirements of the food processor and the rigid U. S. P. specifications of the pharmaceutical manufacturer. Benefit from the quality, stability and variety assured in Vitamin A *right* from Roche.

Fine Chemicals Division • **HOFFMANN-LA ROCHE INC** • Nutley 10, New Jersey
In Canada: Hoffmann-La Roche Limited, St. Laurent, Montreal 9, P.Q.

ROCHE®

Executive Editor
GEORGE F. STEWART

Editor Emeritus
C. OLIN BALL

Assistant Editor
KELVIN DEMING

Board of Editors
C. P. BOLTON
BEN F. BUCHANAN
RICHARD H. FORSYTHE
J. M. JACKSON
REID T. MILNER
A. I. MORGAN, JR.
JAMES W. PENCE
W. M. URBAIN
MAYNARD A. JOSLYN

Business Manager
CALVERT L. WILLEY

Advertising Manager
R. C. SLUNDER

Eastern Advertising Representative
D. K. MACPHERSON

Publication Office
THE GARRARD PRESS

Mailing Instructions:

Editorial Office: P. O. Box 164, Davis, California. ONLY TECHNICAL MANUSCRIPTS and associated material. A pamphlet, "Research Papers for IFT Journals," is available upon request and was last printed in the January, 1961 issue of FOOD TECHNOLOGY.

Business/Advertising Office: 176 W. Adams Street, Chicago 3, Illinois. All other correspondence, news releases, member subscriptions, changes of address (must be received at least two weeks before date of issue), and claims for copies lost in the mails (must be received thirty days after issue, U.S.; ninety days after issue, foreign).

Eastern Advertising Office: 1465 Golf St., Scotch Plains, N. J.

Publication Office: 510 N. Hickory St., Champaign, Illinois. All requests for non-member subscriptions, back volumes, single copies, reprints, etc. Requests for a single reprint should be addressed to the author.

FOOD TECHNOLOGY is published by the Institute of Food Technologists and printed by The Garrard Press.

Copyright, 1961, by the Institute of Food Technologists.

Mailing Permit: Entered as second class matter, Feb. 25, 1947, at the Post Office at Champaign, Illinois under the Act of August 24, 1912.

Subscription Rates. Domestic, U. S. Territories, Canada and Mexico $11.00; Central and South America $12.00 plus $1.00 postage; all other countries $12.00 plus $2.00 postage. Single copies, Domestic $1.50 each; Foreign $1.75 each, both prepaid. Subscriptions are entered on a calendar year basis only. In the event a subscriber cancels, no refund will be made.

Responsibility for statements, points of view, and mention of commercial products rests solely with the author, and is not an endorsement by the Institute of Food Technologists.

food technology

JULY, 1961
Vol. 15, No. 7

features

Highlights of IFT Annual Meeting 5

The Navy's Food and Equipment Needs Outlined by the U. S. Naval Supply Research and Development Facility 8

Importance of Selection and Processing Method for Successful Freeze-Drying of Chicken 18

1961 Awardees Named 25

Some Biological Aspects of Fat Deterioration 33

research

Control of Microorganisms During Preparation of Vegetables for Freezing. I.
Green Beans 329
D. F. SPLITTSTOESSER, W. P. WETTERGREEN, AND C. S. PEDERSON

Control of Microorganisms During Preparation of Vegetables for Freezing. II.
Peas and Corn 332
D. F. SPLITTSTOESSER, W. P. WETTERGREEN, AND C. S. PEDERSON

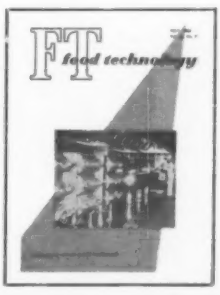
A Simple, Objective Method of Determining Firmness of Brined Cherries 335
JOHN E. BREKKE AND MARION M. SANDOMIRE

Effect of Tylosin and Heat on Spoilage Bacteria in Canned Corn and Canned Mushrooms 338
C. B. DENNY, J. M. REED, AND C. W. BOHRER

Quality of Frozen Vegetables Purchased in Selected Retail Markets 341
J. P. SWEENEY, V. J. CHAPMAN, M. E. MARTIN, AND E. H. DAWSON

departments

International Food Technology 40
Book Reviews 42
Future Meetings 45
News 48
Expansion News 50
Classified Advertising 51
Personnel 51
Advertisers' Index 55



JULY COVER. Efficient mass feeding—this problem was faced and met by the Navy at Recruit Training Command, Great Lakes Naval Training Center, Great Lakes, Illinois. Shown on the cover is a portion of one of four galley areas used in preparing food for 10,000 meals three times daily. Nine pressure cookers stacked in tiers of three are shown on the left, and three kettles, used for soups, stews and braising are on the right. In addition to problems pointed out in the feature article, page 8, the Navy is currently searching for an appropriate type of spoon to replace the outdated wooden type. While the stainless steel kettles and spoons depicted are satisfactory, they are quite expensive. In view of this, many kettles are now made of aluminum. However since a chemical reaction between stainless steel and aluminum could be catalyzed by various foods, a substitute is being sought.

It may be of interest to note that a recruit subsisting at Great Lakes receives an average of 6000 calories per day, at an average cost of $0.94 per day per man. 1,525 dozen eggs are used for breakfast, 5,000 loaves of bread, 5,000 pounds of steak, 5,000 pounds of potatoes, and 3,125 gallons of milk are average daily consumption figures.

Photo and above information supplied by the Supply Department, USNTC, Great Lakes, Illinois.

KELCO COMPANY

KELCO
REFINED ALGIN PRODUCTS

technical bulletin

Use unique Kelco Algin Colloids to improve your food products

In Frozen Foods, Kelcoloid, in acid to neutral foods having oil-water systems, provides emulsion stability. Coarse ice crystal formation is retarded. Kelcoloid holds structure of food, maintains smooth uniform texture, and promotes complete flavor release.

In Gravies, and in Cream, Meat and Barbecue Sauces, Kelcoloid provides efficient emulsion stability, and aids in thickening and bodying, too. Kelcoloid produces properly stabilized, free-flowing sauces that are homogenous and eye appealing, with clean full flavor. Shelf life is measurably extended.

In Salad Dressings, Kelcoloid, highly efficient stabilizer, prevents body separation and markedly increases shelf life. Kelcoloid promotes a uniform, smooth consistency giving dressings a highly desirable, palatable appearance.

No Surer Way to Achieve Effective Emulsion Stability

KELCOLOID HVF, the high viscosity member of this series, is generally recommended for use where a decided increase in viscosity is desired along with effective emulsion stability.

KELCOLOID LVF, the low viscosity member of this algin series, produces excellent emulsion stability and desirable body qualities. The LVF is recommended for use where a high degree of emulsion stability is desired with a minimum change in viscosity and body properties.

YOURS ON REQUEST: Free samples of KELCOLOID and other Kelco algin products, plus Technical Data describing properties, advantages and uses. At your service, too, are highly qualified food technicians ready to give individual attention to your problems. Write without obligation to your nearest Kelco regional office.

Kelcoloid HVF® Kelcoloid LVF® products of Kelco Company

75 Terminal Avenue, Clark, N. J. • 20 N. Wacker Drive, Chicago 6, Ill. • 530 W. Sixth Street, Los Angeles 14, Calif.
Cable Address: KELCOALGIN — CLARKNEWJERSEY

Highlights of IFT Annual Meeting

Record-Breaking Number Attend

Food technologists in record breaking numbers flocked to the 21st Annual Meeting of the Institute of Food Technologists held at the Hotel Statler Hilton in New York May 7-11, 1961.

Emphasizing the global nature of Food Technology, most sessions and many papers touched on the opportunities and responsibilities scientists have in the improvement of the world's food supply and in feeding the populations of the world.

Foreign dignitaries from many lands attended the Annual Meeting and their presence served to underline the international importance of Food Technology as did a report given to Council members on the program for the First International Congress of Food Science and Technology to be held in London in September, 1962. Dr. E. M. Mrak presented the ad hoc committee report and Dr. E. C. Bate-Smith of Cambridge University discussed the program in general terms. (Additional details of the Congress were reported in the May and June, 1961 issues of FOOD TECHNOLOGY.)

J. M. Jackson

Highlights of the Council Meeting held on Sunday, May 7, at which President I. J. Hutchings presided, are as follows:

The 1961 election of officers resulted in the naming of Dr. John M. Jackson, American Can Co. as President-Elect and Dr. H. A. Campbell, Dr. G. E. Felton, Dr. J. T. R. Nickerson and Dr. W. R. Roy as Councilors-at-Large.

Dr. George F. Stewart, Executive Editor, reported on the improved new format in both Institute Journals and indicated that the readership survey of FOOD TECHNOLOGY will be helpful in planning the future course of the Journal.

A recommendation that postage charges on FOOD TECHNOLOGY for foreign members of the IFT be removed effective next January 1, was approved.

President Hutchings reported the action of the Executive Committee in chartering two new IFT Sections: the Gulf Coast Section of New Orleans, Louisiana, and the Texas Longhorn Section located in the Dallas-Fort Worth area.

The recommendation of Dr. John F. Mahoney, Liaison Representative to the Food and Drug Administration, that the FDA be presented with booth space at no charge during the 1962 Annual Meeting was approved as was the L. B. Sjostrom report of the ad hoc Committee on Public Relations recommending the engagement of the firm of Merryfield-Wood & Associates, Chicago, as the Institute's public relations counsel for the fiscal year 1961-1962.

Presenting the report of the ad hoc Committee to Study the Advisability of Establishing a Code of Ethics for Institute Members, Dr. Harold W. Schultz proposed that consideration be given to assembling information concerning professional relations and the status of Institute membership, and his report was accepted.

Action was also taken on a resolution from the Southern California Section which requested an expression of the IFT attitude toward the unionization of the non-supervisory technical staff of the food industry. Since that resolution was introduced the Chicago firm of Winston, Strawn, Smith & Patterson, legal counsel for the Institute, has prepared an opinion on the matter and copies have been sent to IFT members. In addition, a press release prepared by the

---

1. This might have been a "remember when" session as Dr. L. V. Burton, Past President of IFT and Col. Charles S. Lawrence, retired Executive Secretary, discussed other Annual Meetings.

2. Florida and the 1962 Annual Meeting was a chief topic as this group gathered informally. From left they are Ray B. Wakefield, Past President IFT, Calvert L. Willey, newly-appointed IFT Executive Secretary; Dr. Harold W. Schultz, IFT President, and Charles Brokaw, Entertainment Committee.

3. Continuing improvement of the Institute's Journals was probably a subject of the informal conversation being held by Dr. George F. Stewart, Executive Editor of IFT Journals, and M. R. Merryfield, Merryfield-Wood & Associates, public relations counsel for the IFT.

Institute's Public Relations counsel has been issued to media on the West Coast, and to certain nationally-circulated trade papers.

A summary of this legal interpretation was also prepared and sent with a covering letter from the Institute to a select list of top companies and corporation executives in line with the Institute's objective of making its activities and scope better known to management.

In general, the opinion makes it clear that, because of their qualifications as professional employees, members of the Institute of Food Technologists cannot be included in a union of non-professional employees "against their will."

If the matter of affiliation should come to a vote and the majority of the professionals vote for "No Union" (or if less than a majority vote for a union) then the professional group "cannot be represented by the union, regardless of how the non-professional employees vote."

Dr. Arthur N. Prater was reappointed Treasurer for the current fiscal year and W. Ray Junk was again appointed Assistant Treasurer.

Calvert L. Willey was appointed Executive Secretary, succeeding Col. Charles S. Lawrence, and Marian A. Gilchrist was reappointed Assistant Executive Secretary.

A proposal to change the name of the Institute of Food Technologists to the "Institute of Food Science and Engineering" was disapproved; however, the Council gave consideration to a number of suggestions as to an appropriate definitive name for the Institute. A motion to submit four names to the membership for an expression of opinion was approved. The four names, or possibilities, are: Institute of Food Science and Technology, Institute of Food Technology, Institute of Food Science, and Institute of Food Technologists.

1. **Survival and the science of feeding mankind received attention of Technologists attending the 21st Annual Meeting. Shown here in a simulated shelter for family survival are Fred C. Baselt and David Bernard in a shelter designed by federal and state agencies.**

2. **Bonnie Scotland was represented at the 21st Annual Meeting by Douglas B. MacDougall, a fellowship student, and with him is Elinor M. Cohen, an exhibitor.**

3. **The international status—and importance—of food technology was emphasized by the attendance of many distinguished technologists from abroad. This group, all employed by the Kraft Company, travelled from Tokyo to attend the 21st Annual Meeting.**

4. **Here are the people who will play major roles in planning and producing the Annual Meeting in Miami Beach in 1962. From left to right, they are: Dr. Harold W. Schultz, IFT President; Dr. R. A. Dennison, Chairman, Florida Section; W. G. Enns, Publicity Chairman; R. W. Kilburn, Courtesy Committee Chairman; Dr. Betty Watts, Chairman of the Program Committee; C. W. DuBois, Sessions and Banquet Committee; Dr. Harvye Lewis, chairman, Ladies Entertainment Committee; Dr. Wallace R. Roy, General Arrangements Chairman and IFT Executive Secretary Calvert L. Willey.**

The Education Committee report, presented by Dr. Robert M. Schaffner, recommended that efforts be directed to attracting greater numbers of outstanding students for undergraduate and graduate training, but that accreditation not be initiated by the Institute at this time.

Following discussion of a proposal for the establishment of a Board of Directors to replace the Executive Committee, a motion, made by Dr. J. H. Nair, was passed. It directs incoming President H. W. Schultz to appoint an ad hoc committee of seven professional members to study the advisability of setting up a Board of Directors to serve as the legal representative of the Institute and, as such, to have, hold and administer all the property, funds and affairs of the Institute.

In the event the committee reports favorably on the proposal for such a Board of Directors, it is directed to develop a complete plan of reorganization to effect the change and to report to the Executive Committee at its meeting in December, 1961.

Dr. Schultz presented a proposal for a post-meeting conference to be held in Mexico City following the 1962 Annual Meeting of the Institute in Miami Beach, and that recommendation was approved.

A resolution presented by Past President R. B. Wakefield honored retiring Executive Secretary Lawrence by expressing "sincere appreciation for his years of dedicated service to the Institute."

pH MEASUREMENT
with the PHOTOVOLT 115

Helps Insure Quality— Flavor Texture Purity

COMPLETE WITH SINGLE ELECTRODES OR PROBE
$175

Get this full-fledged pH Meter of remarkable accuracy and stability — simple in operation and maintenance — fast and dependable in service.

Write for Bulletin #225
PHOTOVOLT CORP.
1115 Broadway New York 10, N. Y.

Also available: Complete line of pH Meters ■ Reflection and Gloss Meters ■ Densitometers ■ Recorders

FOR TECHNICAL HELP . . .

call the man from Blumenthal

In addition to supplying you with high quality chocolate flavorings and coatings, your Man From Blumenthal will gladly:

1. Discuss prices and prevailing market conditions.
2. Arrange for his laboratory to perform special services that can only be handled by a lab staffed with chocolate technicians and equipped with the latest analytical and pilot plant equipment to produce special types of chocolate.
3. Refer your problems to one of our consultants specializing in technical problems.
4. Conduct research on new ideas suggested by you.

BLUMENTHAL BROS. CHOCOLATE CO.
MARGARET AND JAMES STS., PHILADELPHIA 37, PA.

The Navy's Food and Equipment Needs Outlined by the U.S. Naval Supply Research and Development Facility

Milton E. Ryberg
Head, Applied Sciences Branch

STRATEGIC AND TACTICAL concepts of warfare are being continually changed by technical progress. In seapower two important factors are mobility and concealment. The submarine offers both. The conventional diesel-electric submarine has a crew of some 80 men; the recently introduced nuclear submarine, a substantially greater number.

At the other end of the scale, the Navy's attack aircraft carrier *U.S.S. Independence* has a complement of over 4,000 men. Her flight deck equals the length of three football fields. She accommodates airplanes, ordnance, maintenance, many combat facilities, and the wherewithal to house comfortably and support her crew in a small combat-ready floating city that covers an area roughly four blocks long, half a block wide, and several decks high.

These two examples are typical of extremes in both function and size of the many ships that compose today's U.S. Navy. But all of these ships have a common problem: the problem, so important to morale, of feeding a crew adequately within the confinement of narrow space.

A Well-Fed Crew Is a Happy Crew

Navy messing has followed traditional practices. Though Supply Corps School officers received formal instruction in general mess administration, many have found that their best training came from experience aboard ship.

Traditionally, enlisted men became cooks, bakers, and commissary stewards through an apprentice system. The supply officer leaned heavily on his chief commissary man because he had long experience in running a general mess. Inevitably, some of these human relationships proved better than others, and one ship could be said to "feed better than another." And this is how a morale problem could come about. The competitive spirit among ships was strong. It extended to food because a well-fed crew is usually a happy crew.

Equipment Included a Cookbook

Galley equipment as well as the system of serving food was also a matter of tradition. It followed the concept of the naval architects who designed the ship.

There were schools for cooks and bakers. These helped tremendously in standardizing food preparation.

The development of a Navy cook book aided in meal planning, and preparing subsistence requirements.

World War II Brings New Problems

World War II generated a wide variety of new problems. In the throes of rapid expansion, men came to the Navy from all walks of life. Though some of these men had been cooks in civilian life, the majority had to learn to become cooks. These oft-unwilling tyros were mostly trained on the job.

Other feeding problems stemmed from: the new galley layouts of the many new types of ships and patrol craft being built; the establishment of advance bases throughout the world; and climate and environment as it affected man's food supply and intake.

At the close of World War II it was evident that the many feeding problems encountered by the U.S. Navy during the conflict were of sufficient tactical importance to warrant a continuing research program.

The Research Program's Beginning

Toward the end of World War II a test and development department was set up in the Supply Corps school at Bayonne, N. J. Its first task was to revise the Navy cook book; the old Navy cook book was on the way out. The new approach was to develop a system of 100-ration recipe cards. From this master set evolved a flexible recipe system to meet changing needs. Today there are over 800 recipes in the system.

In 1949 the Naval Supply Research and Development Facility was established, which included a Commissary Research Division with expanded functions. Many notable successes tended to broaden the scope of assigned projects. Accordingly, in 1959 the name was changed to Food Science and Engineering Division, a title more descriptive of the nature of its work.

The Food Science and Engineering Division

This is one of three major divisions of the Facility. It is divided into four branches:

1) The Equipment Branch is concerned with the mechanical and electrical aspects of food service equipment, and the capability of the equipment in preparing good food under all Navy conditions. Where special requirements must be met, either equipment is redesigned or entirely new designs are developed.

2) The Food Service Branch handling the Navy recipe service also conducts industrial engineering studies of food service operations both ashore and afloat. It devises improved methods of cutting manpower and costs. It studies specific foods from the standpoint of decreasing storage space, reducing

"HIRE" THIS FOOD SPECIALIST...

NO SALARY REQUIRED!

- Years of practical experience in solving food production problems!
- Can help with your vitamin enrichment and fortification procedures
- Offers unlimited supply of vanillin
- Know-how of years of leadership in color field

THIS FOOD SPECIALIST is a Sterwin Technically-Trained Representative . . . an expert with technical and practical experience to help you produce better food products more easily and economically.

He's cut time, expense, production steps in dozens of cases . . . is relied on by food manufacturers (large, medium, small) for prompt solutions to color, vitamin, vanillin and other food ingredient problems.

For a new production set-up, or to improve an existing one . . . see your local Sterwin Representative . . . costs you nothing . . . can save you plenty.

Sterwin Chemicals INC.

Subsidiary of Sterling Drug Inc

1450 Broadway, New York 18, N.Y.

Vitamin A man

Eric McLean is our production manager. You might also call him chief officer in charge of assuring trouble-free vitamin A fortification of food products like margarine. This is easily accomplished with our *Myvax® Vitamin A Acetate* or *Palmitate*, or *Myvax Dry Vitamin A Palmitate*.

Mr. McLean also processes fats and oils. So do you. If you have any problems involving the incorporation of his products with yours, we might have the answers.

Distillation Products Industries, Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies, Inc., West Coast • Charles Albert Smith Limited, Montreal and Toronto.

DPi

leaders in research and production of vitamin A

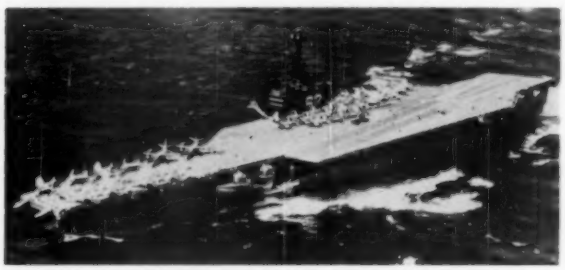
Distillation Products Industries

is a division of **Eastman Kodak Company**

waste, and increasing yield. High-yield foods are under constant study and evaluation.

3) The Applied Sciences Branch conducts chemical, radiological, bacteriological, and detergent studies. It also gives technical assistance and analytical service to the other three Branches. Its projects include the food aspects of Atomic, Biological, and Chemical warfare, specialized detergent problems, compressed flour, butter storage, and similar problems peculiar to the chemical and biological sciences.

4) The Applications Engineering Branch is responsible for galley- and food-service design, and layout involving both ships and shore establishments. It is well known for its design of galley and messing facilities for the newer nuclear-type submarines, and those aboard the super aircraft carrier *Independence*.



The USS Independence (CVA-62), one of the newest additions to the US Fleet. In this super-carrier live about 4,000 men who must be fed nutritious, well-cooked and appetizing meals three times a day anywhere in the world.

Food Science and Engineering Division Personnel

The present staff of about twenty-five comprises a wide range of professional and technical skills. Some staff members are qualified in more than one field. Among the disciplines represented are mathematics, chemistry, biochemistry, physics, bacteriology, food technology, engineering (mechanical, electrical, refrigeration, industrial), quantity food service, and administration and management.

A very important role in the Division's research program is played by service-trained Navy enlisted personnel—rated commissarymen selected on the basis of background experience. These men contribute to the solution of food, equipment, and design problems through their first-hand knowledge of conditions aboard submarines, destroyers, and other Navy ships and installations.

While each of the four branches of the Food Science and Engineering Division is staffed in relation to the general areas of responsibility, the team concept is used to solve problems varying widely in scope and difficulty. This concept assures maximum utilization of scientific and technical capability.

Scope of Problems

The nature and scope of assigned problems are very broad. Problems range from; the development of a stirring paddle to a submarine cooking range; recipe evaluation to the development of Bayonne bread;

Myverol®
Distilled Monoglycerides

	Type 18-00	Type 18-07	Type 18-40	Type 18-85
Source material	Fully hydrogenated lard	Fully hydrogenated cottonseed oil	Prime steam lard	Refined cottonseed oil
Monoester content (min.)	90.0%	90.0%	90.0%	90.0%
Saponification value	155-165	155-165	155-165	155-165
Iodine value	1	1.0 (max.)	50 (approx.)	85 (approx.)
Glycerol content (max.)	1.0%	1.0%	1.0%	1.0%
F.F.A. (max.): as stearic as oleic	1.5%	1.5%	1.5%	1.5%
Specific gravity	0.91 at 80°C	0.91 at 80°C	0.92 at 80°C	0.93 at 80°C
Congeal point (approx.)	68°C	67°C	47°C	46°C
Clear point (approx.)	73°C	76°C	60°C	56°C
Form	Bead	Bead	Plastic homogenized fat	Plastic homogenized fat
Net shipping weight, lb.	250	250	400	400

For the engineering of food texture

Here are four fats for foods, typical of the broad variety of distilled monoglycerides you can get from DPi. Their high monoester content, the result of a unique segregation of fat molecules in the vapor phase, makes possible precise engineering control over the physical structure of foods which contain fats.

High mono content makes these emulsifiers more efficient, hence less expensive, than mixtures of mono- and diglycerides. Emulsions are easier to form and less emulsifier need be used.

Myverol Distilled Monoglycerides are bland, stable, and free from catalysts and soaps. There is nothing in them that might affect taste, color, or odor. To learn which of them might improve your control of food texture, write ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies, Inc., West Coast • Charles Albert Smith Limited, Montreal and Toronto.

distillers of monoglycerides made from natural fats and oils

DPi

Also . . . vitamin A in bulk for foods and pharmaceuticals

Distillation Products Industries *is a division of* **Eastman Kodak Company**

new
from
Twitchell

fruit
flavored
emulsions

ORANGE LEMON
PINEAPPLE LIME
PINEAPPLE-GRAPEFRUIT
PINEAPPLE-ORANGE
CHERRY

Twitchell's Flavored Emulsions are especially designed to meet the exacting requirements of food processors.

Twitchell emulsions enhance the natural flavor and aroma of juices, contribute to stability, yet actually reduce costs in proportion to their quantitative amounts. Aroma and flavor . . . so important for customer appeal . . . are maintained, even after processing.

TYPICAL USES:
• Fruit Fillings • Toppings • Icings
• Purees • Juices • Beverages • Cremes
• Syrups • Fondants

WRITE OR WIRE TODAY FOR SAMPLES
OR FURTHER TECHNICAL INFORMATION
ON OTHER FRUIT FLAVORED EMULSIONS

S. Twitchell CO.
CRESTMONT and HADDON AVES. - Camden 4, N.J.

evaluation of trail rations for Antarctic use to radiation effects involving food stowage in a nuclear-type submarine; the design of a prototype steam-proofer to the complete detailed working drawings for the entire food service operation on an attack aircraft carrier.

The number of subprojects, studies, and minor investigations undertaken totals many hundreds. At the same time, the research program is carefully coordinated with all branches of the armed services to avoid duplication of effort. There is a free and cordial interchange of ideas through resident Navy liaison officers.

The following examples of the scope of the research program illustrate the breadth and depth of the investigations at the Naval Supply Research and Development Facility in Bayonne.

The number in the crew of a nuclear submarine is considerably greater than that of the older diesel-electric type. But the space allotted to feeding could not be increased. Adequate space for feeding the larger crew could come only from more efficient use of the available space.

The USS George Washington (SSBN-598). This newest of the nuclear-propelled submarines carries a substantially larger crew than the older diesel-electric type, but with essentially the same space allotted for food preparation. This poses the problem of more efficient use of the space available.

A mock-up galley of a post–World War II diesel-electric submarine was constructed at the Facility, and several years of intensive research on submarine feeding were begun. Qualified Navy submarine cooks prepared meals in the mock-up while equipment interrelationships, difficulties in food preparation, and other data were collected.

Analysis of the data showed the galley to be inefficient in terms of manpower and space use. An entirely new galley layout with improved equipment resulted from the study.

While the new galley design is now used in the *Polaris* missile-launching submarine, and this study is virtually completed, the research has resulted in several side effects. Some of the developments are

Mold-inhibiting SENTRY Sorbic protects profits through positive control of spoilage

Snow-white, free-flowing SENTRY Sorbic is more than a dependable mold and yeast inhibitor . . . *it's the finest kind of sales insurance.*

In the few years since its development, Sorbic has become one of the food industry's most widely used materials for extending keeping-life by control of spoilage.

At the pH levels of most foods, Sorbic preserves quality and appearance better than any other commercial fungistat. In concentrations lower than 1/10 of one per cent, it effectively lengthens the keeping-life of cheeses, baked goods, fruit juices, citrus products, soft drinks and fountain syrups, wines, pickles, dried fruits, salads, and many other packaged and refrigerated items.

Sorbic is easy to use. It does not affect flavor, aroma, or color of the products in which it is used, and at effective levels it is digested in the same way as butter fat. Sorbic is generally recognized as safe for use in foods, so there is no Food Additive Amendment problem. Standards of Identity and U.S. Department of Agriculture restrictions on meat use are the only limiting factors.

Why not put Sorbic in *your* products? Make *sure* they have the long keeping-life needed to carry them safely from packing plant to time of purchase and use.

For test samples of SENTRY Sorbic (or Potassium Sorbate—CARBIDE's highly water-soluble fungistat) write to Union Carbide Chemicals Company, Division of Union Carbide Corporation, 31st Floor, 270 Park Avenue, New York 17, New York.

UNION CARBIDE CHEMICALS COMPANY

UNION CARBIDE

SENTRY and UNION CARBIDE are registered trade marks.

THE BIG DIFFERENCE IN SPRAY DRIED FLAVORS IS RIGHT HERE

Spray dried, locked in flavors
are nothing more than tiny globules
of concentrated flavor encased in an outer
protective coating which shields it from oxidation,
evaporation and the reaction with other ingredients
which it might contact.
The superiority of FRITZSCHE'S AROMALOK® FLAVORS
is due simply to the fact
that *this core or nucleus is composed of*
the very finest flavoring ingredients made.

AROMALOK®

FLAVORS for use in:

While spray dried flavors are a trifle costlier
than their liquid equivalents,
they offer advantages in certain applications
which can more than offset this difference.
Assured indefinite shelf life and protected
against flavor loss during manufacture
the tendency toward costly overflavoring
is thus avoided. Furthermore,
spray dried flavors are easy to handle and store.
They mix readily and will not separate in the
finished product. They are highly recommended
for use in all powdered products
where flavor retention is a prime consideration.

Let us submit an AROMALOK® FLAVOR *for your product.*

- SOFT DRINK POWDERS
- GELATIN DESSERT POWDERS
- PUDDING POWDERS
- CAKE MIXES
- ICING MIXES
- ICE CREAM MIXES
- SHERBET and WATER ICE MIXES
- PIE FILLER MIXES
- MILK DRINK POWDERS
- CHEWING GUM
- COMPRESSED CONFECTIONS
- PHARMACEUTICAL TABLETS
- TOOTH POWDERS

FRITZSCHE BROTHERS, Inc.

A FIRST NAME IN FLAVORS SINCE 1871

76 NINTH AVENUE NEW YORK 11, N. Y.

Branch Offices and *Stocks: Atlanta, Ga., Boston, Mass., *Chicago, Ill., Cincinnati, Ohio, Greensboro, N. C., *Los Angeles, Cal., Philadelphia, Pa., San Francisco, Cal., St. Louis, Mo., Montreal and *Toronto, Canada; *Mexico, D. F. and *Buenos Aires, Argentina. Plants: Clifton, N. J. and Buenos Aires, Argentina.

finding their way into commercial use; others are being applied to dry docks and advanced bases.

Similar problems are now under study in intermediate-size combat vessels with the objective of increasing efficiency and reducing manpower.

In designing the feeding system aboard the Navy's largest attack aircraft carrier, the *USS Independence*, Navy researchers had to develop a new method of mass-producing bread.

Because of space limitations, the intermediate proofer and molder had to be eliminated from the bread production line. Research not only developed a new method for bread making without the two pieces of equipment previously considered essential, but it cut production time in half.

The new baking method, hailed as one of the greatest advances in fast food production during 1959, is now used in other Navy vessels and in many commercial and institutional establishments.

Close Contact with Industry

The Facility maintains close cooperation with industry. If the results of Navy research are to be economically practical it must work with industry on both committee and company levels. As an example, an item of food equipment not on the market might be needed to meet a modification program. The Navy might design the item and have it manufactured commercially. As a custom-built item the equipment and parts would be very expensive. Furthermore, the original manufacturer might divert his interest to other fields and cease making the item. In consequence, the entire project would be economically unsound.

In working closely with industry, items suitable for both Navy and commercial use are developed at moderate cost to the Government. Thus, Navy research and industry working together contribute to the industrial and national welfare.

Foods, Methods, and Equipment Needs

The Navy stipulates these considerations in the introduction of new foods, methods, and equipment:

1) All new food products, when prepared according to easily understood and easily applied directions, should have an acceptability equal to or better than the prepared conventional product. In the confines of a ship, food is a major morale factor. No food can be used that does not contribute toward a "happy ship."

2) Future strategy and tactics will require that ships remain on station in distant operating areas for extended periods. The operating limitations of the new nuclear-powered weapons systems designed to meet these requirements are now dictated by food storage capacity and human endurance. This means that subsistence items must have a high food yield per cubic foot of space occupied, must contain an irreducible minimum of waste, and must be packaged to fit the storage spaces assigned with a minimum of lost space.

3) Manpower requirements for the new weapons systems demand that the number of men used in the preparation and service of food be reduced to a minimum, and that galley equipment be automated or simplified to the ultimate.

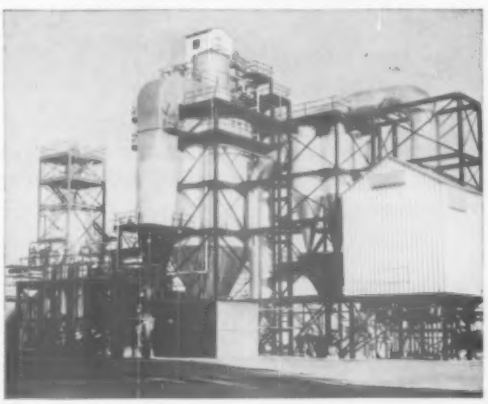
Equipment Remains a Major Problem

Equipment for Navy use continues to be a major development problem. In this area there is the matter of making better use of the human mechanism. In short, there is a need for any type of equipment that will help Navy cooks prepare better food at lower cost.

Some of the items in which the Navy is interested are:

- Ovens and griddles with a more even heat distribution.
- Insulated steam-jacketed kettles with automatic temperature controls.
- Built-in scraper-type mixers.
- Vegetable peelers giving a 10% peel loss or less.
- Quick-cooking meat ovens with roasting losses around 10%.
- Pressure cookers that will both cook and brown meats.
- Griddles that will cook foods on both sides at the same time.

PROCTOR
SPRAY DRYERS



are designed with your product and production requirements in mind. Our engineers can custom build a Spray Dryer for you which will give years of trouble-free production... high production of a quality product at minimum cost. Our engineers will consult with your product development group... run tests on our test equipment... and recommend a spray drying installation specifically designed to solve your particular problems. *Write for Bulletin #442.*

Proctor®
PROCTOR & SCHWARTZ, INC.
Philadelphia 20, Pa.

From Constant Research Comes the Best in TASTE-APPEALING FLAVORS!

Flavors by Givaudan, the result of continuous experience in the production and creation of high-quality products, will assist you to build sales and win consumer approval.

For your every flavor requirement, Givaudan offers natural and imitation flavors of superior quality, stability, and uniformity in taste and odor... backed by our world-wide facilities for raw material manufacturing and our knowledge of consumer tastes and trends.

Our experienced staff will be glad to cooperate with you in working out any flavor problem.

Givaudan Flavors Inc.

321 West 44th Street, New York 36, N. Y.

• Deep-fat fryers that will cook more rapidly and accurately.

• Refrigerators that will maintain food at high quality for long periods.

• A small water meter with automatic shut-off, for use wherever water must be measured.

• Sensing devices by which a cook can tell when a griddling or broiling product is done.

• Devices that will lower a product into a deep-fat fryer, hold it there until a sensing device determines that it is properly cooked—and then lift it out.

• Continuous deep-fat fryers and griddles that occupy little space.

• Small automatic devices for measuring flour, sugar, and similar materials, eliminating a need for scales.

Food Research and Development

While there is an extensive research program being conducted by industry in the broad fields of food and beverage development, the special subsistence requirements of the Navy for carrying out its ever-changing mission are not yet fulfilled. The following product needs constitute a few of the problems in research and development to be solved before Navy requirements are satisfied.

Dairy Products Needed

• A high-quality dried whole milk for drinking. Present products deteriorate rapidly in storage, resulting in off-flavors and poor solubility. Present non-fat instant products are fairly well accepted when made up to the total solids content of fresh milk. The desired product should be suitable for extended storage at ordinary warehouse temperatures, should reconstitute rapidly without residue, and should be comparable to fresh milk in flavor and mouth feel.

• A good low-priced dehydrated cottage cheese that can be reconstituted easily and stand up in storage for at least two years.

Poultry Products

• While there is now available an excellent mixed, frozen, table-grade egg, it is suitable only for omelets, French toast, and scrambling. Today's frozen eggs are fresher in flavor than most of the shell eggs received aboard ship, because of storage problems and time factors involved in transport, storage, and re-shipment via the supply system. But there is need for a frozen egg that can be used for fried eggs-to-order. It should also occupy a minimum of space.

Meats Have High Priority

• There is an urgent need for high-quality dried meats at prices close to those for conventional products. They must stand up in unrefrigerated storage, have typical flavor and texture, be easily rehydrated, and have long storage life.

• Meat wastes and cooking losses should be left ashore. Precooked frozen meats in a 25-man ration package are needed. They should be easy to thaw,

KLENZADE PROCESS AND C.I.P. AUTOMATION SERVICES

KLENZADE

D. A. Seiberling and R. B. Douglas work with plant management in reviewing operating requirements and applying the latest proven developments in processing and sanitation techniques for maximum plant efficiency and product quality.

A well coordinated engineering staff consisting of B. N. Pavlakovic, E. N. Brunsell, R. R. McCourt and L. Mahler designs and supplies specific systems and equipment recommended in the Engineering Analysis.

P. F. Smith, H. J. DeBruin and V. Christensen, specialists in process piping fabrication, control system design, and automation cleaning equipment, put complete engineered systems into operation.

Complete Automation Program

• SANITATION CHEMICALS • APPLICATION EQUIPMENT
• ENGINEERING SERVICES

KLENZADE PRODUCTS, INC.
Dept. 22G Beloit, Wisconsin

reheat, and separate into portions. At the same time, they should retain their fresh flavor.

Needs in Dehydrated Vegetables

• A dried tomato product suitable for drinking or cooking is needed. The best that is now available is a liquid concentrate. The desired product should stand storage for three years, retain a good red color, be quickly rehydrated, and give a good fresh-tomato flavor.

• Cabbage, blanched, dehydrated, is now only fair and needs improvement. The present product should be available in larger pieces, while the improved product should keep a firm texture, have a green color and typical flavor, and should stand storage for two to three years.

• A good dehydrated celery is needed. The product supplied to the Navy has been tough and stringy, and has received questionable acceptance. The same qualities desired in cabbage should also apply to celery.

• There is need for improved potatoes that come in larger pieces with rehydration qualities similar to the chips or dice of present potatoes. In short, a potato for French frying.

• A good dehydrated carrot, whole corn, and beet have yet to be developed. Similarly, green beans are small in piece-size and dark in color.

In the general area of dehydrated fruits, the Navy would welcome a greater variety. These should retain their distinctive flavor and piece shape.

Importance of Selection and Processing Method For Successful Freeze-Drying of Chicken*

Edward Seltzer
Thomas J. Lipton, Inc., Hoboken, N. J.

THE LATEST in a long line of methods for commercial preservation of meat is dehydration. Of the several methods available, freeze-drying is currently receiving the most attention. This method, not unlike others, has two important prerequisites to success: 1) The product must be conspicuously better than when dried by conventional methods, and 2) the value of the solids content of the product must be high enough that freeze-drying costs will be but a small percentage of the sales price. And even if these requirements are met, caution cannot be relaxed. The freeze-drying of a meat product such as chicken, for example, requires unusual care or the product may be tough and stringy and of poor shelf life.

If chicken meat is ground sufficiently fine, tenderness and ease of rehydration are not as important problems as is keeping quality. Dried chicken tends to deteriorate very rapidly when exposed to air and stored at summer temperature. At moisture contents above 3%, carbonyl-amine browning occurs readily. Then, too, the dark meat tends to oxidize to a deep brown. Fat oxidation is rapid too, and with it rancidity is a conspicuous defect unless the meat is protected by high-vacuum or inert-gas packing. The induction period of fat rancidity can be completed during processing and drying, so that rancidity increases very rapidly thereafter.

The peroxide value of the fat is usually markedly lower in freeze-dried meat than in the undried product. The reason may be evaporation of the lipid compounds under high vacuum, or possibly deoxygenization. The advantages of freeze-dried meat can be lost in a few days if the dried product is exposed to oxygen. As indicated, the fat and pigment oxidize rapidly. Color changes occur in the meat even in an inert atmosphere, though much more slowly.

Whereas the use of vacuum retards fat oxidation during drying, our experience has shown that air drying can be very hazardous. For example, the fat of undried cooked chicken meat generally has a peroxide value of 3 or less, compared to a value of usually less than 1 for vacuum-dried or freeze-dried meat. Atmospheric drum drying to 3–3.5% moisture content (which may take only about ½ min) may raise the figure to 4–6. Fast air drying (about 1 hr) may raise the figure to about 7. If air drying is slow (4 hr or more) the peroxide value may rise above 50; and if 6 hr or more are required, it may rise to over 250. Antioxidants, such as NDGA, retard but do not prevent this oxidation.

Harper and Tappel, at the University of California, believe that freeze-drying can produce chicken of reasonably good rehydration characteristics that can be cooked by ordinary methods and yield a ready-to-eat product of good color and flavor; they add, however, that it has a dry texture and is tough. In our experience, any method of drying, including freeze-drying, tends to toughen chicken meat. The proteins

* Based on paper given at the Fall, 1960, meeting of the Research Council, Institute of American Poultry Industries.

Which of these features do you look for in a FOOD OR BEVERAGE HOSE?

Freedom from Odors and Taste?
Ease of Cleaning and Sterilizing?
Transparency?
Flexibility?
Long Service Life?
Wide Range of Standard Sizes?

TYGON® plastic TUBING

B44-3 *combines them all!*

Remaining flexible throughout the full range of normal operating temperatures, Tygon plastic Tubing, Formulation B44-3, is also as clear as glass, permitting visual inspection and control of flow.

Non-contaminating and non-toxic, Tygon Tubing B44-3 neither imparts nor absorbs taste or odors, is safe with even the most flavor-sensitive products.* Because of its smooth, hard bore, Tygon Tubing is easily cleaned, can be sterilized with steam (open end method) or bactericides.

Tygon Tubing is non-aging, highly resistant to abrasion, and has a flex life 10 to 12 times greater than rubber. More than 65 standard sizes, up to 4″ I.D., are available in continuous lengths.

*For processed milk and milk products, use Formulation B44-4X.

See why Tygon Tubing, Formulation B44-3, is almost universally the preferred plastic for handling foods and beverages. Get complete information — write today for your free copy of Bulletin T-100.

443-F-3

PLASTICS & SYNTHETICS DIVISION

U. S. STONEWARE
AKRON 9, OHIO

TYGON is a registered Trade Mark of The U. S. Stoneware Co.

are apparently easily denatured. Only very low drying temperatures can be used with the extended periods required in lyophilization if one is to minimize these defects. A 110°F platen temperature, as specified by the QMC, is safe in our experience; it can be exceeded only when drying techniques receive special and elaborate modifications. Further, if heating is used during rehydration, there will be additional toughening. Toughening increases even when raw meat is freeze-dried.

With the best-known conservative techniques, only very tender chicken meat of excellent quality deserves the high cost of freeze-drying. Some of the short-cut mass-production methods currently used appear to have no regard for tenderness as an important quality factor. Lipton and some other users of chicken meat use cooking methods and other processing measures that preserve whatever inherent tenderness exists in the raw product. All of those concerned, however, must have good understanding of technical control if we are to win consumer acceptance for this product.

Some rules-of-thumb for selecting poultry suitable for dehydration are:

1) Exclude small, immature birds (especially broilers and fryers). Such stock is usually more costly to buy and to process (per pound of dry product); it is a fallacy to assume that such material produces the most tender meat. In fact, the white meat of young birds toughens easily during commercial processing, and seems especially susceptible to toughening during dehydration and rehydration.

2) Roasters, roosters, and hens are the best type of stock to use. Exceptions are most cull hens of the egg-producing types, which seem to have tough meat and virtually no fat marbling. The tenderness of old hens and roosters should be improved by rehabilitative feeding.

3) Some feeds are known to promote unstable fat.

4) Large hens are generally acceptable, though there may be excessive fat that may be very susceptible to rancidity.

5) Male and female birds in the yearling class, especially cross-breeds, seem to be the most promising for freeze-drying.

Some of the traditionally tough egg-laying varieties may be rehabilitated to acceptable tenderness before slaughter. Conversely, the birds that are most promising from the standpoint of good genetics and proper rearing may become hopelessly toughened by high-speed modern processing methods. Thus, trends in the poultry processing industry seem to diverge. On one hand, scientists determine the benefits and detriments of good and bad processing; on the other, engineers develop streamlined low-cost processes as though they were dealing with hardware instead of sensitive physiological material.

Examples of these opposing trends can be seen in results at the Western Regional Research Laboratory. One shows tenderness benefits from 20-hr chilling in slush ice, and another explains how an automatic chiller in an "advanced plant" reduces chill time to 40 min (which automatically makes inherently tender birds tough unless relieved by long holding after thawing).

FIG. 1.

It is very probable that, in so-called advanced plants, birds will be toughened by being "subscalded" (about 140°F) and then beaten by rubber fingers for feather removal. Though efficient, these methods must cause any user who depends on tenderness to cringe at the deliberate destruction of the good work of the breeder, nutritionist, and grower.

A. A. Klose, of Western Regional Laboratory, has stated the matter very simply:

"Minimum requirements for the production of tender poultry: 1) Hold the carcass in a chilled or unfrozen state at least 12 hours before freezing. 2) Don't depend on the housewife to do the aging before cooking. 3) Avoid scalding at too high a temperature or for too long a time. 4) Stop 'beating' your poultry."

The influence on tenderness of poultry selection and processing may be objectively measured with the shear-press test supplemented by taste-panel evaluation. In employing the Kramer apparatus (Fig. 1), diced meat cubes are screened for uniformity of size. The sample of meat, equal to 50 g dry solids, is then cooked in salted broth, strained, and placed in the press, the 3/8-in. cubes allowing random fill as regards orientation of the meat fibers with respect to the "teeth" of the shear press. The sample is next subjected to three successive shears, and the maximum value for each run is used to compute an

Table 1. Effect of machine-plucking vs hand-plucking on tenderness of chicken.[a]

Plucking procedure	Kramer shear-press value (lb)	
	Control	Freeze-dried[b]
130°F scald, machine-plucked directly after scalding		
Light meat	1113	1553
Dark meat	.....	1227
No scald, hand-plucked directly after slaughter		
Light meat	937	1383
Dark meat	.....	1173
No scald, hand-plucked after hanging overnight at 40°F		
Light meat	890	1277
Dark meat	.....	960

[a] Barred Plymouth Rock roasters, 5–7 mo old; lean; live wt = 4.5–4.75 lb.

[b] Sample rehydrated before testing.

MELT POINT *Kaola-Style*

How Durkee Research Took the Oily After-taste Out of Frozen Desserts

THE PROBLEM: *complex.* Consumers didn't like a lot of things about frozen desserts. Especially oily after-taste and waxy film left in the mouth. The cause was the high melting point of vegetable fats which were being used to provide stand-up characteristics. Frozen dessert manufacturers needed a fat base designed specifically for their use—and Durkee's Technical Research Staff set out to give them one.

THE SOLUTION: *painstaking.* New fat bases were developed. Frozen desserts were made... tested... tasted... and even produced in Durkee's pilot plant which simulates actual plant conditions. The result was Kaola, a patented all-vegetable fat base with a melting point below body temperature. Today, taste panels invariably prefer frozen desserts made with Kaola over those made with competitive products.

THE SIGNIFICANCE: *rational.* Kaola, the unique frozen dessert fat, is another example of Durkee know-how and research facilities helping food producers market better products more economically. We'd welcome an opportunity to provide comparable assistance to you whenever your product or process warrants further attention. Just drop a line to

DURKEE TECHNICAL SERVICE

Department FT • 900 Union Commerce Building • Cleveland 14, Ohio
Jamaica, N. Y. • Louisville, Ky. • Berkeley, Calif. • Chicago, Ill.

QUALITY Glidden PRODUCTS

average value for the samples. This is repeated in a duplicate run on another sample of meat. The shear value range for very tender chicken is 650–1000 lb. Samples with values up to 1350 lb appear to be acceptably tender. Above this level the lot is rejected in our operation if sensory evaluations concur that the sample is tough. Occasionally, the panel will say that meat is tender with shear values up to 1650 lb.

Table 1 shows some results we have obtained on the effect of processing on tenderness.

Machine-plucking in these tests was for minimum time on a single-drum machine. All lots were aged (after plucking and before cooking) for 3 days at 40°F for optimum relaxation of rigor, and thus should have achieved maximum tenderness.

There are several points of interest:

1) Scalding and machine-plucking, even when conservative, have a toughening effect that is further magnified by dehydration. If these same birds had been subscalded and plucked in a multiple-station line they would very likely have been toughened beyond usefulness for freeze-drying (with shear values probably averaging about 2000 lb).

2) Young birds have a high toughening potential during rough processing and dehydration.

3) Dark meat, partly because of the higher fat content, is tenderer than light meat.

Another example of some of our results is in Table 2.

Table 2. Effect of immediate vs delayed machine-plucking on tenderness of chicken.[a]

Plucking chronology	Kramer shear-press value (lb)	
	Control	Freeze-dried[b]
130°F scald, machine-plucked directly after scalding		
Light meat	1440	1783
Dark meat	1136	.....
130°F scald, machine-plucked after hanging overnight at 40°F		
Light meat	1066	1480
Dark meat	860	.....

[a] Barred Plymouth Rock roasters; 5–7 mo old; live wt 4.5 lb.
[b] Rehydrated before testing.

Holding overnight before machine-plucking permits relaxation of rigor so that mechanical defeathering scarcely affects tenderness. Nevertheless, overnight holding would certainly be frowned upon by USDA inspectors—and the efficiency experts. Perhaps this challenge will be met by alternate measures, such as sedatives or immobilizing techniques or by injecting proteolytic enzymes *in vivo*.

Heavy, mature birds have a far lower toughening potential in all processing steps, including dehydration. This finding appears often in the literature, especially for turkeys.

An example is in Table 3. These data include:

1) With hens of this type, when scalding, plucking, and chilling are all in accordance with conservative practice, holding overnight before plucking sometimes offers little advantage.

2) Dark meat is not much more tender than light meat in such birds even though fat content is almost twice as high as in the light meat.

A repeat of the preceding test on a similar batch of poultry gave the results in Table 4.

Table 3. Effect of immediate vs. delayed plucking on tenderness in chicken.[a]

Plucking chronology	Kramer shear-press value (lb)	
	Control	Freeze-dried[b]
130°F scald, machine-plucked directly after scalding		
Light meat	1110	1280
Dark meat	1053	1147
130°F scald, machine-plucked after hanging overnight at 40°F		
Light meat	1067	1293
Dark meat	1023	1230

[a] Black sex-linked yearling hens; live wt *ca.* 8 lb each.
[b] Rehydrated before testing.

Table 4. Effect of immediate vs delayed plucking on tenderness of chicken hens.[a]

Plucking chronology	Kramer shear-press value (lb)	
	Control	Freeze-dried[b]
130°F scald, machine-plucked directly after slaughter		
Light meat	1230	1417
Dark meat	1127	1183
130°F scald, machine-plucked after hanging overnight at 40°F		
Light meat	990	1047
Dark meat	943	1047

[a] Black sex-linked yearling hens; live wt *ca.* 8 lb each.
[b] Rehydrated before testing.

The conclusion to be reached is that, though not all batches of poultry enjoy conspicuously improved tenderness with conservative processing, improper scalding temperatures and excessive machine plucking are to be avoided. Otherwise one may negate virtually all the added tenderness that genetics and proper feeding offer, especially if the birds are to be dehydrated.

Acknowledgments

Test data presented herein were developed by Edmund Attarian and Felix Markow, Thomas J. Lipton, Inc.

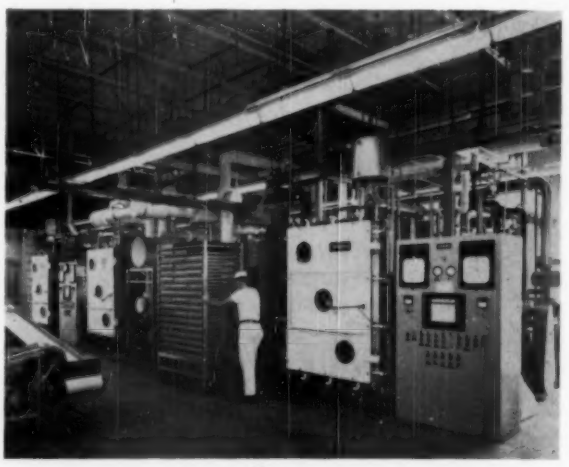


FIG. 2.

it's time
for a change
from traditional
FOOD ACIDULANTS

develop new, different
taste-appeal
by adding
or substituting

National®
MALIC ACID

National
SUCCINIC ACID

National
ADIPIC ACID

Now you have a choice of five food acids: Traditional Citric or Tartaric and the uncommonplace Malic, Succinic or Adipic*.

All are approved for food use. All are amply available in consistently uniform quality. All are fairly priced for the job they do. But each has a different place in your formulas to impart just the right taste and after-taste to your products.

TASTE-TEST ALL 5 NOW

Words can't describe tastes or after-tastes. You'll never know what National Malic, Succinic or Adipic Acid can do for your products until you taste-test them in your current formulas or recipes. That's why we urge you to send for generous working samples and complete technical data for your laboratory and test kitchen. Use the handy coupon for prompt action!

*U.S. Pat. Nos. 2,657,996; 2,698,803; 2,971,848

Please send ☐ TECHNICAL BULLETIN
working sample of ☐ MALIC ACID
☐ SUCCINIC ACID ☐ ADIPIC ACID
☐ Have representative call by appointment

Name_____

Company_____

Address_____

_____

T-2

Allied Chemical

NATIONAL ANILINE DIVISION
40 RECTOR STREET, NEW YORK 6, N. Y.
Atlanta Boston Charlotte Chicago Dallas Greensboro
Los Angeles Philadelphia Portland, Ore. Providence San Francisco
In Canada: ALLIED CHEMICAL CANADA, LTD.,
1450 City Councillors St., Montreal 2 100 North Queen St., Toronto 18
Distributors throughout the world. For information:
ALLIED CHEMICAL INTERNATIONAL • 40 Rector St., New York 6, N. Y.

IF THEY CAN BE PRESSED INTO A TABLET...MORTON WILL COMBINE THEM FOR YOU!

Morton will work with either seasoning suppliers or canners to custom-produce the right flavoring tablets for every job!

As part of its complete service to canners, packers and processors, Morton Salt Company will make tablets containing the exact combination of salt and other flavoring agents desired, following the user's specifications.

In fact, Morton has, on occasion, produced tablets that do not even contain salt!

Morton combination tablets are precision made to your exact requirements. Ingredients may include any flavoring agents which can be combined into a tablet, in any size from 10-grain to 400-grain.

Morton's Complete Dispensing Service—Morton also offers a complete line of tested and approved dispensers, including Salt Tablet Depositors which deposit up to 700 tablets a minute with guaranteed accuracy. They will help you reduce costs, eliminate waste and assure better flavor control. All equipment is installed and serviced by Scientific Dispensing Company Division of Morton Salt Company.

How many things go into your product that should be combined in tablet form?

I would be interested in the possibilities of combining

_____ *in tablet form.*

Name_____

Title_____

Company_____

Address_____

City_____ State_____

MORTON SALT COMPANY

INDUSTRIAL DIVISION

Dept. FT-7

110 North Wacker Drive, Chicago 6, Illinois

1961 Awardees Named

To recognize his pre-eminence in and contributions to the field of food technology, Dr. Helmut C. Diehl has been named 1961 Nicholas Appert Awardee. President of the IFT in 1949, Dr. Diehl is a nationally recognized pioneer research scientist and administrator in the field of frozen foods and refrigeration.

H. C. Diehl

In 1924 he initiated investigations of frozen foods in the Pacific Northwest, and in 1931 established the Frozen Pack Laboratory in Seattle for the United States Department of Agriculture, the first of its kind in the world. Between 1941 and 1943, Dr. Diehl was Chief, Commodity Processing Division, Western Regional Research Laboratory, U.S.D.A., and from 1944 to 1958, served as Director, The Refrigeration Research Foundation. In 1957, the University of Rhode Island awarded him the honorary degree of Doctor of Science, for his contributions to the American food industry.

Although his formal training has been in forestry, plant physiology, chemistry and biochemistry, Dr. Diehl has been associated with the food industry for nearly forty years. In addition to this association, he has found time to become an authority on the life of the Hopi Indians in Arizona, and is a sports-car and race enthusiast, personally driving a Mercedes Benz.

The Nicholas Appert Award, originated by the Chicago Section of the IFT, consists of a Bronze Medal (furnished by the Chicago Section) and an honorarium of $1,000.

1961 Babcock-Hart Awardee

Scientist and administrator Emil M. Mrak, Chancellor of the Davis campus of the University of California, is the 1961 Babcock-Hart Awardee. This is the second IFT award Dr. Mrak has received in recent years; he was the Nicholas Appert Awardee in 1957, and the following year had the added distinction of being president of this organization.

E. M. Mrak

The Babcock-Hart award is granted to an individual who has made outstanding technological contributions which directly affect the nutritional well-being of the public. It is donated

RUM FLAVOR

...puts the "YUM" in your product!

• Delight the palates of young pirates and their parents by adding Flavorex Rum Flavor to your product. Great for a *hearty accent!* Exquisitely exotic as an *extra touch of flavor!*

• Use Flavorex Rum Flavor in *baked goods, confections, puddings, eggnog mixes, ice cream,* and other foods. You'll be doubly rewarded these ways . . . perfect for your present formulas . . . helps earn consumers' preference for your product.

• Flavorex Jamaica Style Rum is a flavor concentrate of natural and synthetic esters produced in our own plant and blended by our masters of the art. Run a batch test. You'll discover that every fragrant drop adds mellow tropical sunshine to your product. Write for free sample, or place a trial order today.

Rum Flavor No. B224 . . . $12 per gallon

Better Flavors for Better Products

FLAVOREX CO., INC.

302 S. CENTRAL AVE., BALTIMORE 2, MD.

Put it all together, it spells *SERVICE*

Fast, dependable delivery. Years of experience. These are the extra dimensions Miles adds to the versatile talents of citric acid.

Miles has developed a unique deep-fermentation process which produces citric acid in quantities that assure you of a steady supply. Shipments — small quantities or large — are made from more than 70 warehouses, strategically located and abundantly stocked. This means extra insurance for you against

production bottlenecks and shortage of supply. Add to this Miles' years of experience in applying citric acid in the production of foods, beverages, pharmaceuticals . . . and in using citric industrially.

This experience can be working for you; wherever you are, there's easy access to citric acid, hydrous or anhydrous, from Miles. Put this versatile acid — and the extra dimensions of Miles service — to work. Call or write today for more information.

MILES Chemical Company
Division of Miles Laboratories, Inc.
Elkhart, Indiana – COngress 4-3111

Where will you use this nutritious lubricant?

Here is one member of a unique class of products, *Myvacet® Distilled Acetylated Monoglycerides*. It can now be used in food equipment.*

It will be used because it offers much more than excellent lubricating properties. It is wholesome and nutritious. It is free from taste or odor, and stays that way because it forms no rancid odors or gums. It far outperforms traditional edible oils in resistance to oxidation.

As a lubricant, it works well even under pressure. Compared with ordinary edible oils it has greater polarity. This allows it to orient on various surfaces to form more tenacious films which last and last.

For samples and more information on the various types and viscosities of *Myvacet Distilled Acetylated Monoglycerides* available, write ***Distillation Products Industries,*** Rochester 3, N. Y. Sales offices: New York and Chicago • W. M. Gillies, Inc., West Coast • Charles Albert Smith Limited, Montreal and Toronto.

*U. S. Food & Drug Regulations, Sec. 121.1018

Suggested applications for *Myvacet Distilled Acetylated Monoglycerides*

Confectionery—Slab dressing; release agent for molds, tubs, and bowls; lubricant for machinery and cutting knives.

Baking—Divider oil, trough and pan grease, lubricant for slicing equipment.

Meat Packing—Packer's oil, cutting-knife and slicer lubricant, general-purpose lubricant for meat-processing equipment.

Dairy—Lubricant for valves, filler pistons, capping machinery, and other equipment.

Canning, Packing, and other Food Processing—Lubricant for any operation where contamination of foodstuff is a possibility.

producers of ***Myvacet®***
Distilled Acetylated Monoglycerides

DPi

Also . . . Myverol Distilled Monoglycerides . . . vitamin A for foods and pharmaceuticals

Distillation Products Industries *is a division of* **Eastman Kodak Company**

Control of Microorganisms During Preparation of Vegetables for Freezing. I.

Green Beans[a]

(Manuscript received March 20, 1961)

D. F. Splittstoesser, W. P. Wettergreen, and C. S. Pederson

New York State Agricultural Experiment Station, Cornell University, Geneva, New York

SUMMARY

Methods of controlling microbial contamination of cut and French-style green beans during processing for freezing were studied. Chlorinated sprays reduced the number of microorganisms originating from belts. The practice of holding French-style beans in reserve resulted in significant growth of microorganisms on this product. Growth of organisms was not adequately controlled on enclosed equipment such as a filling machine. The results stress the need for improved sanitary design of equipment, more effective cleaning methods, and modifications in processing procedures.

MICROBIOLOGICAL STANDARDS for frozen foods have been established or are being considered by various governmental and commercial groups (Frozen Food Standards Committee, 1959). While most current interest appears to be with the precooked foods, standards may in time be extended to frozen fruits and vegetables. In precooked frozen dinners, the highest bacterial counts have been found in the vegetable portion (Holcomb and Weiser, 1959). Frozen packaged green beans commonly contain hundreds of thousands of bacteria per g. This research was conducted to learn more about the factors responsible for high bacterial counts in green beans and to determine what practical methods might be used to control this contamination.

A number of investigators have shown that surfaces of processing equipment where plant juices collect are principal sources of contaminants (Hucker *et al.*, 1952; Pederson, 1947; Vaughn *et al.*, 1946). Several reports have dealt with methods of controlling this contamination. Haynes and Mundt (1948) found that chlorinated sprays reduced the number of microorganisms present on green beans. Vaughn *et al.* (1946) recommended the following for reducing postblancher contamination: straight in-line processing, design of sanitary equipment, continuous cleaning of equipment, use of potable water, and in-plant freezing.

EXPERIMENTAL METHODS

Samples. Green beans in different stages of processing were collected from the lines of area factories. The samples were routinely frozen in one-pint polyethylene bags for plating the following day. Freezing was effected by placing the bags over dry ice or in the factory freezer immediately after collection of the samples. The beans were transported to the laboratory in an insulated chest containing dry ice. The samples were then held in a −23°C freezer until bacteriological analyses could be made.

Enumeration of organisms. Before the freezer bags were opened, the frozen beans were broken into small pieces. Aseptic techniques were used to transfer 11 g from the bags to sterile blender jars. The weighed samples were blended for 1 min with 99 ml of water. Appropriate dilutions were made in water blanks, and the samples were plated by standard pour-plate techniques with tryptone-glucose-yeast extract agar. After 48 hr at 32°C, the colonies were counted with a Quebec colony counter.

RESULTS

During 1959 and 1960 bacteriological surveys were conducted at three New York State factories processing cut green beans and French-style green beans for freezing. In some of the factories, obviously faulty processing methods were responsible for large numbers of microorganisms in the product. However, even in factories where many of the usually cited causes of contamination had been eliminated, frozen beans with high microbial counts were still a serious problem. Much of the data presented in this report are the results of studies made at one of the larger factories, Factory X, processing green beans. This factory was a relatively modern operation in that in-plant chlorination assured suitable water for cooling and fluming, straight in-line processing of most vegetables resulted in little lag between blanching and packaging, and the cartons were conveyed directly from packaging into a plate freezer where freezing was rapid.

Cut green beans. The results of surveys conducted at Factory X over a two-year period and at Factory Y illustrate the effect of processing methods on degree of contamination (Table 1). It can be seen that beans processed in Factory X contained the greater number of microorganisms and that the inspection belts and filling machines were primarily responsible for this. Little contamination occurred prior to inspection at Factory X because the beans were conveyed from the blancher to the belts in flumes containing 5 ppm available chlorine. The inspection belt was also a major source of contamination at Factory Y. However, the number of organisms on the beans was reduced significantly in the flumes which followed the inspection belts. Cut beans were not heavily contaminated by the filling operation at Factory Y. This processing line was relatively small, and the product was packed into the cartons by hand instead of by machine.

Table 1. Microbial contamination of cut green beans during different stages of processing.

Factory	Processing stage	No. samples	Av count/g ($\times 10^3$)
X	Before blanch	4	1800 ± 1200[b]
	After blanch	2	1.4 ± 1.1
	End reels 1–4	21	5.1 ± 3.4
	End inspection belt 1–3	22	25 ± 4.4
	End inspection belt 4	7	1100 ± 520
	In hopper	25	260 ± 110
	End filler elevator	11	590 ± 470
	In filler hopper	14	540 ± 470
	After packaged	24	880 ± 870
Y	Before blanch		400
	After blanch		4
	End inspection belt		120
	End flume		49
	At filler table		44
	After packaged		52

[b] 95% confidence limits.

[a] Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 1257, March 13, 1961.

Inspection belt No. 4 at Factory X contributed many more organisms than any of the other three belts. Although the belts were of similar rubber construction, No. 4 was older and had received considerable use. A few worn areas were evident along the edge of this belt. Contamination from belt No. 4 influenced the averages obtained for the subsequent operations (Table 1) since the beans had originated from all four belts. If belt No. 4 were eliminated from the line, the average counts on samples collected following inspection would have been considerably lower. Elimination of this belt would also have reduced the 95% confidence limits shown for these samples. An average count of 510,000 on beans from belt No. 4, compared to an average of 14,000 on beans from the other belts, obviously was responsible for much of the variation in counts.

After crossing the inspection belts, the beans at Factory X were collected in hoppers, where they were held until they could be conveyed into filling machines via bucket elevators. The hoppers *per se* were not major sources of contamination, nor did significant growth of microorganisms occur while the product was being held in these containers. The average holding period for cut beans in the hoppers was 90 minutes. Little increase in microbial counts could be detected until after the beans had been held 3 hours.

After finding that the inspection belts were major sources of microorganisms, attempts were made to reduce this contamination by scrubbing the surfaces with a commercial cleaner-sanitizer. This would be a practical means of controlling belt contamination if the build-up of organisms following cleaning was not too rapid. Although the treatment produced a very clean-appearing belt surface, microbial contamination of cut beans was not reduced. In one study, for example, the average count on 6 samples collected prior to cleaning was 16,000 per g. After about one man-hour was devoted to cleaning the belt, six samples yielded an average count of 15,000 per g.

Continuous cleaning of an inspection belt was first tried at Factory X during the middle of the 1960 processing season. The first trial consisted simply of positioning a hose under the belt so that the return surface was continuously flushed with water. On this day, the average microbial count prior to continuous cleaning was 71,000 per g of beans. Almost immediately after flushing, this count dropped to 6,000, and the average for the first day was reduced to 1,900 per g.

Permanent sprays were then installed on the underside of all inspection belts. By operation of the belts and sprays during shut-down hours as well as when beans were being processed, the surfaces were kept clean, and contamination from all belts, including No. 4, was reduced to a very low level (Table 2). As can be seen by these data, the average reduction was 71% for beans from belts 1–3, and over 99% for beans from belt 4.

After the sprays were installed hand scrubbing of the belts by the clean-up crew was discontinued. Contamination originating from the belts remained low for the rest of the season, except for 5 days when the chlorination system failed. During this period the average count increased to 120,000 per g. Thus, 5 ppm chlorine in the wash water was an important factor in continuous cleaning of this equipment.

Although cut beans were no longer subject to heavy contamination during most stages of processing at this factory, the average microbial counts in the final product remained over 200,000 per g. The earlier surveys had shown that the elevator and the filling machine hopper and pockets were major sources of contamination (Table 1). These areas continued to contribute large numbers of microorganisms after belt contamination had been reduced by the sprays (Table 3). Attempts were made to eliminate this final source of organisms by scrubbing the elevator and all parts of the filling machine with the sanitizer-cleaner, rinsing with water, and then subjecting the surfaces to live steam. Microbial counts remained the same, however (Table 3). Apparently, too many areas were inaccessible to the treatment. Because of filler contamination, a product with a consistently low microbial count was not achieved at Factory X. The results emphasize that contamination must be controlled at all stages of processing.

Table 2. The influence of sprays on microbial contamination of cut green beans at the inspection belt. Factory X.

Condition	Belts 1–3		Belt 4	
	No. samples	Av. count/g[a] ($\times 10^3$)	No. samples	Av. count/g[a] ($\times 10^3$)
Before sprays	22	25 ± 4	7	1100 ± 520
After sprays	13	7.2 ± 3	8	3.3 ± 1

[a] With 95% confidence limits.

Table 3. Influence of cleaning the filling machine on contamination of cut green beans.

Sampling position	Before cleaning		After cleaning[a]	
	No. samples	Av. count/g ($\times 10^3$)	No. samples	Av. count/g ($\times 10^3$)
End of elevator	3	27	4	47
In filler hopper	3	120	4	33
After packaging	3	220	4	230

[a] See text for methods.

French-style green beans. Green beans of a sieve size No. 5 or larger were processed as French-style beans. Since the three factories under study used different methods for processing French-style beans, problems in contamination of this product differed to some extent (Table 4). As with cut beans, the data for Factory X represent surveys conducted over two processing seasons, whereas the data for the other two factories are from single surveys.

Table 4. Microbial contamination of French-style beans during different stages of processing.

Factory	Processing stage	No. sample	Av counts/g ($\times 10^3$)
X	After blanch	5	0.38 ± 0.14[a]
	End flume to slicer	9	0.61 ± 0.30
	After slicer	12	96 ± 59
	After shaker-sprays	23	21 ± 9.9
	End belt to filler	17	54 ± 32
	In filler	12	170 ± 78
	Bulk reserves	5	280 ± 210
	Weighing reserves	14	830 ± 420
	After packaged		420 ± 170
Y	After blanch		5
	End inspection belt		140
	End flume to slicer		33
	After slicer		130
	After spray wash		51
	On filling table		410
	Weighing reserves		490
Z	Before slicer		690
	After slicer		2900
	In rotary cooler (after blanch)		100
	End inspection belt		500
	End conveyor belt		1300
	Weighing reserves		5500
	Packaged		1600

[a] Average ±95% confidence limits.

A problem that the three factories shared was that no machine appears to exist that will fill the correct weight of French-style beans into cartons. At Factory X a machine was used to add the approximate quantity of beans to cartons. The individual packages were then weighed, and beans were added or removed (by hand) as required. The added beans were obtained from small "weighing reserves" at each of the scales. The method in the other factories was similar except that filling was done completely by hand. The weighing reserves at all three factories yielded extremely high microbial counts (Table 4). Apparently, actual growth of microorganisms on these beans was responsible. Although not all packages were underweight and received such beans, the very heavy contamination of these reserves caused them to be a serious problem.

At Factory X, the filling operation often lagged behind the other phases of processing. When this occurred, some of the beans were diverted from the filling machine to a large trough, where the product was held as "bulk reserves." These reserves were used whenever the flow of beans from the cutters abated. Their effect on the final product can be seen by comparing the counts at the filler with those at the end of the conveyor belt. The higher count at the filler resulted because it

was there that the bulk reserves were being combined with product directly from the conveyor belt.

The bean-slicing machines were a source of contamination at Factories X and Y. The slicers would have been a more serious problem if many of the organisms had not been removed by the sprays that followed this operation. At Factory Z, extremely large numbers of organisms were introduced by the slicer. Most of these organisms should have been killed by the blanch that followed the slicing operation. The exact reduction effected by the blanch was not determined, because samples could not be collected until the beans were in the rotary cooler. The relatively high counts at this stage may have originated from the cooler water. The turnover of water in this unit was relatively slow, and therefore conditions may have been sufficiently static to permit a build-up of organisms.

Although belts were a source of contamination at all three factories (Table 4), Factory Z had the most serious problem. Following the blanch, the beans passed over a metal inspection belt and were then conveyed via three additional metal belts to the filling area. It can be seen that the microbial counts at the end of these belts was 10-fold greater. The length of these belts, plus the fact that the act of transferring beans from one belt to the other afforded opportunity for new contact with contaminated surfaces, is thought to be responsible for this heavy contamination. Thus, similar contamination might have resulted had the belt been of a rubber construction. During one survey at this factory, samples were collected at the end of the belts before and after the noon-hour clean-up. The treatment, which consisted mainly of flushing the belts with water, produced clean-appearing belt surfaces. Microbial contamination of the beans, however, was not reduced. The average count of 10 samples was 570,000 per g prior to cleaning and 730,000 per g during the first hour after cleaning. These results suggest that continuous cleaning of the belts will be required to reduce this contamination effectively.

Variations in microbial counts. The 95% confidence limits were included with the data obtained at Factory X to show the type of variation obtained when similar surveys were made over a two-year period. Although the confidence limits are large, individual surveys showed the same trends in counts indicated by the averages in Tables 1 and 4. This is illustrated by microbial counts obtained in samples collected at different times during a single processing day (Table 5). It can be seen, for example, that, although contamination of cut green beans varied considerably, counts were always higher for samples at the end of the inspection belt than for beans obtained from the reel that preceded this belt.

It is difficult to define many of the variables responsible for the fluctuation in counts in Table 5 because, in a large factory, many significant events may occur simultaneously. A few of the many factors that may influence counts are the numbers of organisms on the beans before processing, the quantity of product passing through the line, bean maturity, and the relative humidity and temperature of the ambient air.

Table 5. Variation in microbial counts between individual surveys conducted on a given day.

	Count/g ($\times 10^3$)				
	Cut green beans		French-style beans		
Survey time	In reel	End insp. belt	Before slicer	After slicer	After spray
7:00 A.M.	29	57	0.95	170	57
10:00 A.M.	0.9	52	0.25	220	12
12:45 P.M.	4.8	20	0.35	110	10
3:40 P.M.	10	75	1.1	75	17
4:40 P.M.	3.8	43	0.1	96	15
6:15 P.M.	1.6	31	0.1	30	32

DISCUSSION

Heavy microbial contamination of green beans at the three factories can be attributed to: 1) poor equipment design, 2) lack of effective cleaning procedures, and 3) faulty processing methods.

The rotary cooler used in the French-style bean line at Factory Z (Table 4) is an example of poor equipment design. In a properly designed unit, microorganisms should not grow in the cooling water. A well designed filling machine should lend itself to effective cleaning. Arduous cleaning of a filling machine did not reduce contamination from this source (Table 3). Even had cleaning been more successful, the treatment might have been effective for only a short time, because of the rapid growth of microorganisms. This brings up the subject of effective cleaning procedures.

The results indicate that continuous cleaning or some type of in-place cleaning will be necessary for control of microorganisms in many unit operations. In addition to the filling machine, the slicers and conveyor belts need this type of cleaning. The effectiveness of continuous cleaning of an inspection belt was demonstrated (Table 2). A similar cleaning system is badly needed for the belts at Factory Z (Table 4).

Faulty processing methods were largely responsible for the heavy contamination of French-style beans. The practice of holding these beans in weighing and bulk reserves permitted significant growth of microorganisms. The methods of handling this product must be changed. The contamination of weighing reserves might be controlled by devising a routine in which the turnover rate of these beans is fast enough to eliminate the opportunity for microbial growth. Only one of the factories used a system in which large quantities of beans were held as bulk reserves. It seems that processing methods at this factory could be modified to eliminate these reserves. If the reserves could not be eliminated, growth of microorganisms could be suppressed by chilling these beans.

Microbial standards are most valuable when they provide information about the conditions under which a food has been processed. A prerequisite to the establishment of realistic standards, therefore, is complete understanding of the factors that might be responsible for a given microbial population. The results of this study indicate that the lack of practical methods for controlling growth of microorganisms is a major cause of heavy contamination of green beans. Until improved methods of combatting this contamination are made available to the processor, it seems likely that microbial counts over 200,000 per g of this frozen vegetable product will not be uncommon.

REFERENCES

Frozen Food Standards Committee. 1959. *Assoc. Food & Drug Officials U. S. Quart. Bull.* **23**, 183.

Haynes, Richard, and J. Orvin Mundt. 1948. These chlorine sprays improve processed green beans. *Food Inds.* **20**, 71.

Holcomb, R. E., and H. H. Weiser. 1959. Bacteriology of precooked frozen dinners. *Bacteriol. Proc., Soc. Am. Bacteriologists* 1959, 7.

Hucker, G. J., Robert F. Brooks, and Arthur J. Emery. 1952. The source of bacteria in processing and their significance in frozen vegetables. *Food Technol.* **6**, 147.

Pederson, Carl S. 1947. Significance of bacteria in frozen vegetables. *Food Research* **12**, 429.

Vaughn, Reese H., Theresa C. Stadtman, and Ray W. Kueneman. 1946. Control of microorganisms in frozen food plants. *Quick Frozen Foods* **9**, 76.

Control of Microorganisms During Preparation of Vegetables for Freezing. II.

Peas and Corn*

(Manuscript received March 20, 1961)

D. F. Splittstoesser, W. P. Wettergreen, and C. S. Pederson

New York State Agricultural Experiment Station, Cornell University, Geneva, New York

SUMMARY

Microbial contamination of peas and whole-kernel corn during processing for freezing was studied. Contaminated equipment surfaces were a major cause of high microbial counts on these vegetables. The adhesive properties of corn juices presented special problems in the cleaning of processing equipment. The need for better methods of controlling contamination is discussed.

PREREQUISITE to establishing realistic standards for frozen foods based on microbiological analyses is a thorough understanding of the factors responsible for microbial contamination during processing. Contaminated equipment surfaces and processing methods that permitted growth of organisms were shown to be causes of high microbial counts on cut and French-style frozen green beans (Splittstoesser *et al.*, 1961). To reduce contamination, modifications of certain processes were suggested to the cooperating companies. For example, continuous cleaning of belts with chlorinated water sprays was shown to be practical and effective. Contamination of green beans, however, was not adequately controlled during all stages of processing, because effective methods were lacking for cleaning certain equipment. The results emphasized the need for improved equipment design and cleaning methods.

Problems in microbial contamination often differ with the individual frozen vegetables. This is to be expected, of course, because of differences in physical and chemical properties of the vegetables as well as differences in the methods used in their processing. This report deals with the sources of microorganisms on peas and corn, and with studies on practical methods of controlling this contamination.

METHODS

The methods were as described previously (Splittstoesser *et al.*, 1961).

RESULTS

Peas. In 1959 and 1960, surveys on the processing of green peas were conducted at three factories, W, X, and Z. The average results in surveys over the two seasons at Factory X, along with the results of single surveys at the other factories, show the microbial counts found on peas during different stages of processing (Table 1). The 95% confidence limits included with these data illustrate the variation obtained.

At Factory X, the blanched peas were cooled as they were conveyed by flume to the inspection belts. During this operation the microbial counts increased about tenfold, but actual contamination was low (Table 1). Contamination during cooling was heavier at Factory Z. The reason is not understood, because conditions were similar at both factories in that the cooling water was chlorinated and not reused. Possibly the cooling reels, used at Factory Z, offered surfaces more favorable for growth of organisms than did the flume pipes. The peas at Factory W were also cooled by a flume. There, samples could not be collected until the peas were deposited on a belt. However, since high counts were not found at this stage, the cooling water apparently was not a major source of contamination. In-plant chlorination was not used at this factory.

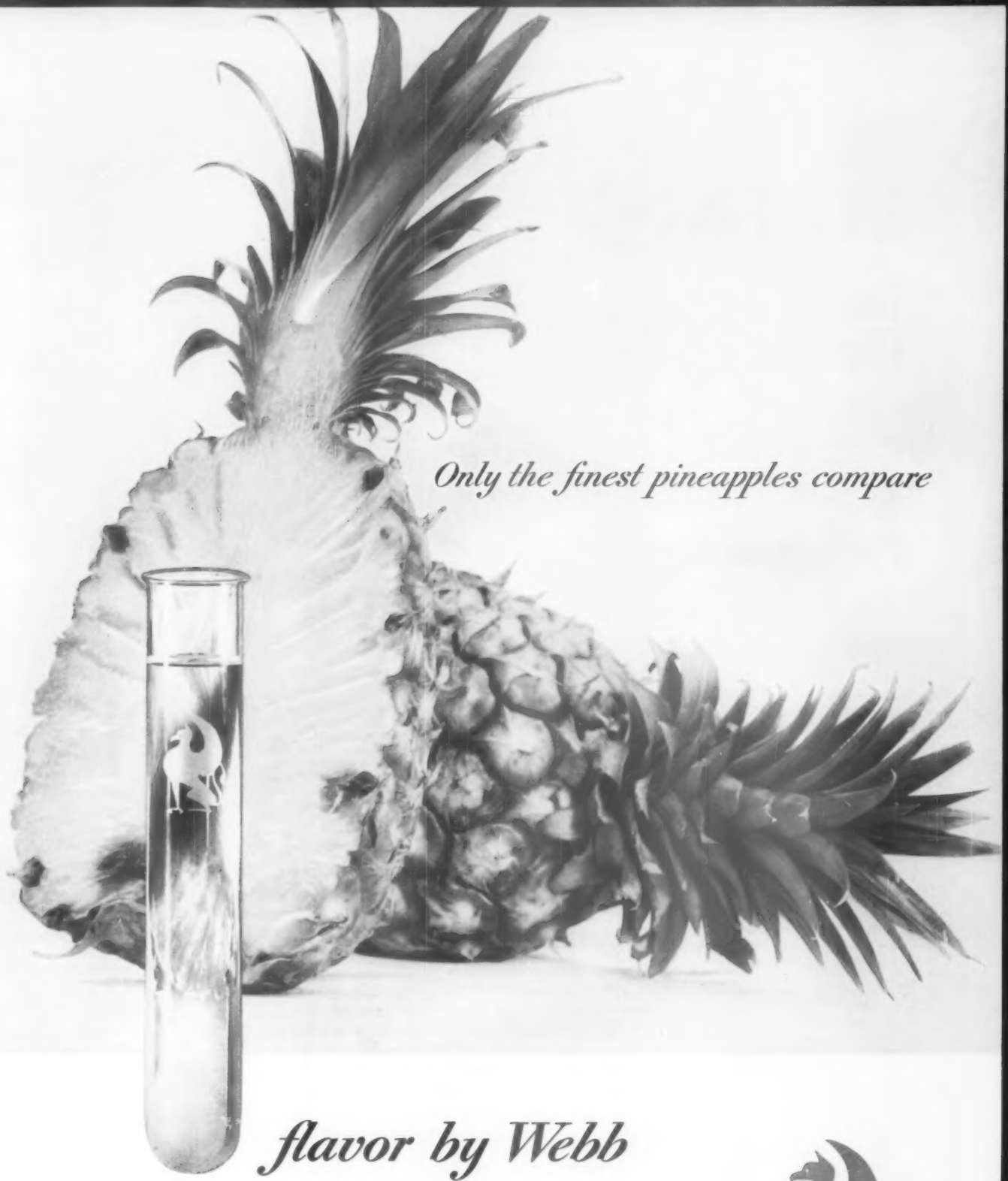
Contamination from inspection belts differed considerably (Table 1). At Factory X, belt No. 4 was responsible for much heavier contamination than belts 1–3. At the other two factories no increase in counts could be attributed to the inspection belts. Since the belts at the three factories were of a similar rubber construction, it was first thought that these results primarily reflected differences in equipment cleanliness. Further studies, however, revealed that an important factor was the quantity of peas being conveyed across the belts. When only a few peas were being inspected, almost all were in contact with the belt surface. When the flow was heavy, many of the peas did not touch the belt and therefore had no opportunity to pick up microorganisms directly from this source. This is illustrated by the data obtained at Factory X, where the microbial counts on peas collected only a few minutes apart varied as much as 10-fold (Table 2). These data indicate that the inspection belts were actually contributing large numbers of microorganisms. However, because usually only a fraction of the peas were affected, the heavily contaminated product was diluted by other peas or was missed in sampling.

Table 1. Contamination of green peas during different stages of processing.

Factory	Processing stage	No. samples	Av. count/g ($\times 10^3$)
X	Before blanch	5	87 ± 50[a]
	After blanch	5	0.5 ± 0.2
	In reels end of flume	33	5.8 ± 2.2
	End inspection belt 1–3	32	14 ± 4.5
	End inspection belt 4	6	510 ± 110
	In hopper	19	45 ± 26
	End elevator to filler	7	49 ± 27
	In filler hopper	11	43 ± 21
	After packaged	18	83 ± 23
Z	Before blanch		900
	After blanch		0.16
	In cooling reel		39
	On elevator to inspect. belts		24
	After inspection belts		34
	On elevator to filler		47
	After packaged		100
W	Before blanch		98
	On belt after flume		14
	On elevator to inspect. belts		66
	End inspection belts		41
	After packaged		140

[a] ± 95% confidence limits.

* Approved by the Director of the New York State Agricultural Experiment Station for publication as Journal Paper No. 1258, March 13, 1961.



flavor by Webb

Rich, ripe pineapple is one of the superb synthetic flavors perfected by Webb. It is available in several liquid versions and in spray-dried form to suit all applications. For samples and usage information to meet your specific requirements, please call or write Webb. Food flavor specialists for over 50 years.

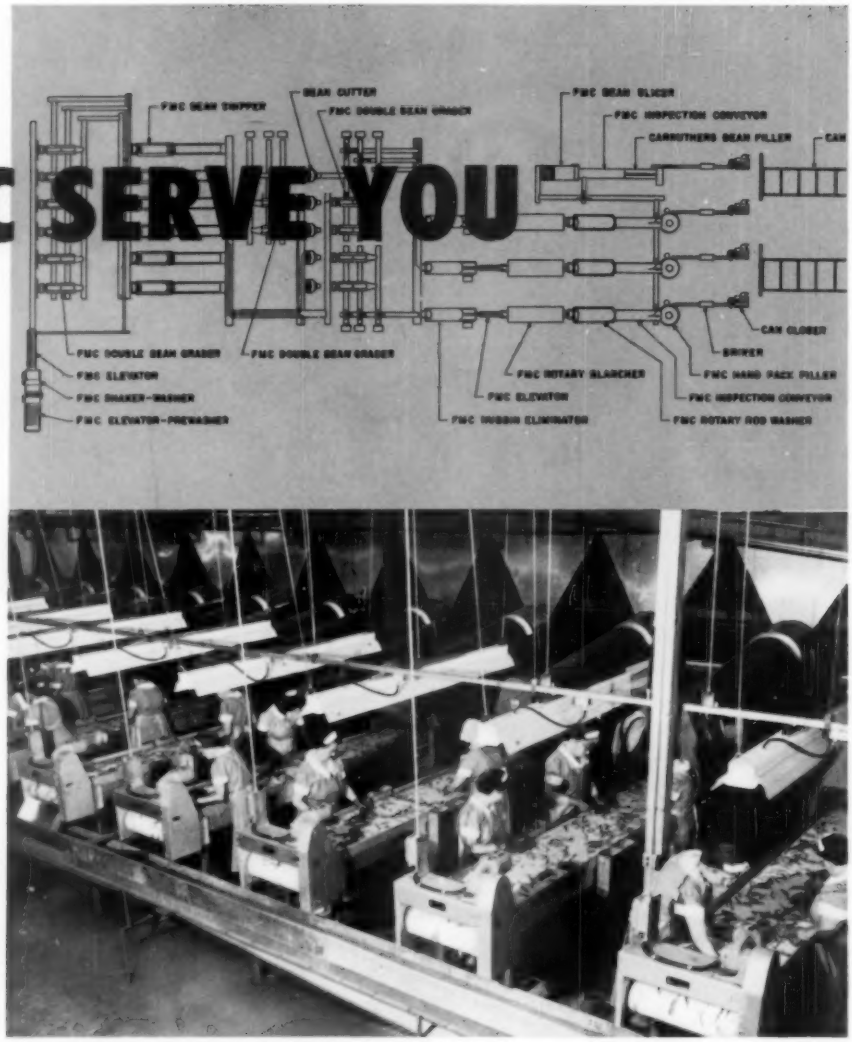
R. D. WEBB & CO., INC.

STIMPSON AVENUE AND STILES STREET, LINDEN, NEW JERSEY

LET FMC SERVE YOU

from Planning

to Performance



FMC Bean Equipment installed at Northwest Packing Co., Portland, Ore.

Known the world over for more than 70 years as a leader in the development and production of advanced food preparation and processing machines and equipment, FMC is also recognized throughout the food industries as the most reliable source for progressive engineering and planning services.

Whether your problem involves consultation regarding an improvement in production line performance, the complete planning of a new plant – from floor plan through research and development, operating techniques, machine performance studies and field testing – or assistance in installation and start-up procedures, FMC's broad background of application engineering experience is available. A letter or a phone call will start things moving.

Dedicated to serving the Food Industries through better equipment for better food products.

Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Canning Machinery Division

General Sales Offices:
WESTERN: SAN JOSE, CALIF. • EASTERN: HOOPESTON, ILL.

332B

Although the flow of peas across belt No. 4 was generally sparse, there was evidence that this factor alone was not responsible for the heavy contamination shown in Table 1. The number of organisms originating from this belt was greater than that from the other belts when flow was similar (Table 2).

Table 2. Effect of the quantity of peas crossing the inspection belt on the microbial count per gram.

Belt no.	Sampling time	Flow at time of sampling[a]	Av. count/g ($\times 10^3$)	
			Before belt	After belt
1	10:20 A.M.	Medium	5	5
2	10:21 A.M.	Sparse	1	100
	10:27 A.M.	Medium	....	8
	12:36 P.M.	Sparse	7	30
	12:40 P.M.	Heavy	....	3
3	10:25 A.M.	Sparse	5	9
4	10:22 A.M.	Sparse	8	1,000

[a] Sparse, all peas in contact with the belt surface; medium, peas in a layer 1–2 in. thick; heavy, peas in a layer over 2 in. thick.

Studies on green beans also showed that belt No. 4 yielded the greatest number of microorganisms (Splittstoesser *et al.*, 1961). With green beans, most of the product was in contact with the belt surface and there was less disparity in flow. Belt No. 4 was the oldest of the four belts, which may explain the differences in counts. Besides the worn areas evident along the edges of this belt, the surface was undoubtedly covered with minute pits and cracks. It seemed likely that large populations of microorganisms had developed in these flaws and were a major source of contamination.

Attempts to clean one of the belts gave indirect evidence that the crevices in the inspection belts did harbor large numbers of microorganisms. In this trial, a belt was flushed with water and then covered with a heavy coat of a cleaner-sanitizer compound containing trisodium phosphate and sodium hypochlorite as the active ingredients. After all surfaces were vigorously scrubbed with coarse steel-wool pads, the belt was thoroughly rinsed with water. This treatment effectively removed the vegetable stains and produced a very clean-appearing, white belt. Contamination, however, was significantly increased for the first hour following cleaning (Table 3). These results suggest that, although much of the surface contamination was removed, the treatment loosened some of the growth that had developed in the belt flaws. When inspection was resumed, water from the peas may have floated many of these organisms to the surface of the belt, where contact could be made with the vegetable.

Table 3. Effect of cleaning an inspection belt on the number microorganisms contaminating peas.

Conditions	Sampling time	Av. count/g ($\times 10^3$)	
		Belt No. 1	Belt No. 2 (control)
Before cleaning	8:55 A.M.	18	7
	10:05 A.M.	12	....
	10:30 A.M.	8	....
	11:00 A.M.	22	32
	11:45 A.M.	51	....
	12:00	18	7
After cleaning[a]	12:35 P.M.	180	....
	12:40 P.M.	240	7
	1:15 P.M.	74	....
	1:30 P.M.	15	30
	2:05 P.M.	32	20
	2:30 P.M.	18	....
	3:00 P.M.	14	18

[a] See text for cleaning methods.

At Factory X the inspected product was collected in hoppers, where it was held until it could be conveyed into the filling machine via a bucket elevator. A more direct system was used by the other operations, with belts conveying the peas directly from the inspection belt to the filling machines. The hopper method did not result in an appreciable increase in counts, because the hold period was generally too brief to permit microbial growth. The final source of contamination at Factory X was the filling machine (Table 1). It can be seen that much of this contamination was introduced during the terminal stage of the filling operation since the increase in counts was not detected until the peas were added to the cartons. In comparison to inspection belt No. 4, the filling machine was not a major source of microorganisms. However, the fact that a build-up of organisms did occur in this equipment suggests that if cleaning were neglected, the filling machine might become a very serious problem.

Whole-kernel corn. Studies on contamination of corn during processing were made at Factory X. After a steam blanch, the principal steps in preparing corn for freezing were: cooling, cutting the kernels from the cob, washing, inspection, and packaging.

The general appearance of the corn line differed markedly from that when peas were being processed. Casual inspection of equipment used in the processing of peas usually did not reveal the areas of heavy contamination. For example, high counts from inspection belt No. 4 (Table 1) were not suspected until after surveys had been made. With corn, however, the appearance of many areas indicated they would be sources of large numbers of microorganisms. Corn fragments trapped in starchy juices coated most equipment surfaces. Large amounts of kernels had collected under conveyor belts and other equipment. The return surfaces of some belts were in contact with this material. The adhesive properties of the corn juice, along with the quantity of tissue fragments resulting from the cutting operation, were largely responsible for this condition.

The first heavy contamination of corn occurred on the large belt that transported the ears, after blanching and cooling, to a dozen or more cutting machines (Table 4). Since at this stage the kernels were still on the cobs, most of the organisms were undoubtedly restricted to the outer surface. The fact that such high counts were obtained when only a portion of a given kernel was in contact with the belt indicates that extremely large numbers of microorganisms were originating from this source.

Table 4. Contamination of whole-kernel corn during different stages of processing.

Processing stage	No. samples	Av. count/g ($\times 10^3$)
End cooling belt (after blanch)	17	3.2 ± 2.1
On cutter belt	41	300 ± 71
On belt after cutters	42	700 ± 170
End belt to washer	11	1300 ± 290
After washer	18	170 ± 69
End inspection belt	32	250 ± 72
End belt to filler	8	1800 ± 1100
After packaged	29	870 ± 280

Following the cutter belt, the counts became progressively higher until the corn entered the washer. Washing removed almost 90% of the microorganisms, but the corn was recontaminated by the inspection and conveyor belts. At times, extremely heavy contamination originated from the belt that transported the corn to the filling machine. This was one of the belts, referred to previously, under which large masses of material collected.

One of the early studies on methods of reducing contamination of corn was to measure the effect of cleaning a belt. The cutter belt was selected for treatment because the corn was not heavily contaminated prior to this belt. The belt was coated with a cleaner-sanitizer, scrubbed with stiff brushes, then carefully rinsed with water. About two man-hours of labor were involved. The cleaning reduced microbial contamination of corn by the cutter belt by more than 50% (Table 5)—a significant reduction, but counts were still high. Furthermore, counts rose appreciably 90 minutes after cleaning. The cutters may have been partly responsible for the rapid build-up of organisms. These machines were located on both sides of the belt, and it seems likely that they were creating an "aerosol" of contaminated corn juices.

Table 5. Contamination of corn before and after cleaning the cutter belt.

Condition	Sampling time	Av. count/g ($\times 10^3$)
Before cleaning	10–11 : 00 A.M. (5 samples)	680
After cleaning[a]	1 : 00 P.M.	270
	1 : 35 P.M.	210
	2 : 00 P.M.	110
	2 : 30 P.M.	360
	3 : 30 P.M.	360
	4 : 30 P.M.	440

[a] See text for cleaning methods.

In 1960, sprays were installed on the return side of the cutter belt as well as on most others used in the corn line. It was hoped that this method of continuous cleaning might be as effective in reducing contamination as similar sprays had been in the processing of cut green beans (Splittstoesser *et al.*, 1961). The results (Table 6) indicate that this system did not sufficiently reduce contamination on belt surfaces: corn processing will require more effective cleaning devices.

DISCUSSION

Microbial contamination during processing is less of a problem with peas than with many other vegetables. Several factors appear responsible. The product is essentially intact, and therefore less soluble material and tissue are available to collect on equipment surfaces and serve as a substrate for microorganisms. Only a few processing steps follow the blanch, thus minimizing the opportunity for recontamination or growth of organisms on the product before freezing. Flumes, which are commonly used to convey peas, afford less opportunity for the build-up of microorganisms than do conveyor belts.

The level of contamination at the three factories studied was not as high as has been found in similar surveys (Frazier, 1958). Contamination from flume and cooling water appeared to be a major problem in some of the West Coast factories since the average count on peas at the end of the flume was 240,000 per g. It is not known whether heavy contamination from this source is common. The results of our work indicate that a build-up of large numbers of organisms in this water should not occur. At Factory X, for example, although the flumes were not cleaned throughout the season, peas obtained from this source consistently yielded counts under 10,000 organisms per g (Table 1).

At the time the pea lines were surveyed, the factories were not using continuous cleaning to reduce equipment contamination. Sprays have now been installed on the return side of the inspection belts at Factory X. These sprays are expected to be as effective in reducing contamination of peas, as they were with cut green beans (Splittstoesser *et al.*, 1961). Even without continuous cleaning, average counts did not greatly exceed 100,000 per g. The surveys indicate, therefore, that peas processed under just ordinary conditions of sanitation should yield standard plate counts below 200,000 organisms per g. Continuous cleaning of belts and careful attention to other areas should produce a product with counts consistently under 100,000 per g.

The development of large populations of organisms on processing equipment was responsible for heavy contamination of whole-kernel corn. The adhesive properties of corn juice favored this build-up of organisms and made their removal difficult. Belts were the major source of contamination. The cutters and filling machine also undoubtedly harbored large numbers of microorganisms. Much of this contamination, however, appeared to be masked by the belts. For example, although slime was often evident on the surfaces of the filling machine, no increase in microbial counts during packaging was observed (Table 4). A saturation point may have been reached with respect to the number of organisms that could adhere to the surface of the kernels. Once belt contamination is controlled, growth of organisms in the cutters and filling machine may become more evident.

In a corn line, belts present special problems in sanitation. Neither periodic scrubbing (Table 5) nor continuous cleaning with sprays (Table 6) proved adequate. Improved methods of continuous cleaning or modifications in methods of processing are needed. More powerful sprays or some continuous scrubbing device might prevent material from accumulating. Shorter or fewer belts would result in less surface to become contaminated. Since washing reduced counts significantly (Table 4), flumes might be used to replace some belts. This would be successful, however, only if an excessive amount of water-soluble nutrients were not extracted by this treatment.

Table 6. Contamination of corn before and after the installation of sprays to clean belts continuously.

	Without sprays		With sprays	
Sampling position	No. samples	Av. count/g ($\times 10^3$)	No. samples	Av. count/g ($\times 10^3$)
On cutter belt	23	340 ± 45	18	240 ± 87
On belt after cutters	19	830 ± 120	23	600 ± 300
End of inspection belt	9	210 ± 99	23	260 ± 95

Some form of in-place or continuous cleaning may also be required for the cutters and filling machine. The cutters can be dismantled readily, and therefore lend themselves to thorough cleaning. Periodic cleaning would be successful, however, only if the build-up of organisms in this equipment was not extremely rapid.

High microbial counts in whole-kernel corn were not uncommon in samples obtained from retail sources. Many processors apparently have problems similar to those found in this study. Our work indicates that gross contamination of this product will continue to be a problem until practical methods are developed for removing and controlling growth of microorganisms on processing equipment.

REFERENCES

Frazier, William C. 1958. "Food Microbiology." p. 71. McGraw-Hill Book Co., New York.

Splittstoesser, D. F., W. P. Wettergreen, and C. S. Pederson. 1961. Problems in the control of microorganisms during the preparation of vegetables for freezing. I. Green beans. *Food Technol.* **15**, 329.

A Simple, Objective Method of Determining Firmness of Brined Cherries

(Manuscript received March 14, 1961)

John E. Brekke and Marion M. Sandomire
Western Regional Research Laboratory,[a] Albany, California

SUMMARY

A simple puncture meter and its use for measuring the firmness (texture) of brined cherries are discussed. Sampling studies and examples of the application of this device are given. Reliable objective estimates of the changing firmness of brined cherries in barrels can be made by testing samples of 18 cherries per barrel at 100-hour intervals.

STUDIES on textural deterioration of brined cherries (Ross *et al.*, 1958; Yang *et al.*, 1959) have been greatly facilitated by a simple puncture meter for estimating firmness of the cherries. This spring-loaded push gauge is used to force a pin of known diameter through the skin and into the flesh of a brined cherry. The tissues resist puncture up to a certain applied force, and then the pin breaks through the tissue. This maximum force is indicated by a sliding clip positioned beside an inscribed scale (Fig. 1). This instrument provides an objective method of measuring the firmness of brined cherries as an improvement over subjective evaluations of firmness that have been the only means at the disposal of the industry. The importance of a reliable objective measurement of texture cannot be overemphasized in view of a potential softening problem. In fact, heavy losses have been suffered by large segments of the brining industry in several years when an unexplained softening phenomenon destroyed hundreds of tons of brined fruit.

The principle of puncturing samples of fruits and vegetables to estimate firmness or texture has been used for many years in various applications. A device for puncturing was used for estimating toughness of corn kernels by Culpepper and Caldwell (1930). Rosenbaum and Sando (1920) used a puncture meter in studies on tomatoes and their susceptibility to infections. Lewis *et al.* (1919) described a pressure device for measuring maturity of pears. The firmness of brined cucumbers has been determined with a USDA fruit tester, according to Bell *et al.* (1950). Reported here is a nondestructive method of measuring the texture (firmness) of brined cherries. The punctured cherries are returned to the barrel or tank to be processed into the final product.

[a] A Laboratory of the Western Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

PUNCTURE METER

Description. A Chatillon[1] spring push gauge, 0–500 g, with L. S. Starrett Company Vise B with minor modifications and provided with stainless-steel tips, was used. Fig. 1 is a picture of the puncture meter with the modified sliding indicator, marked A. Fig. 2 is a scale drawing of the modified sliding indicator. It can be seen that the inside bearing surface of the indicator, which bears on the guide rod, is ⅜ in. long. The tiny spring that holds the ball bearing against the guide post exerts only enough pressure on the ball bearing to hold the sliding indicator in position, but does not resist its sliding measurably. Tips of several different diameters were compared, and a tip 0.08 in. in diameter was found to be satisfactory. The meter is easily calibrated by pressing the tip against one pan of a balance and adjusting collar C so the meter gives the same reading in grams as does the balance. To resist the corrosiveness of fruit juices and brine, the instrument should be made of stainless steel.

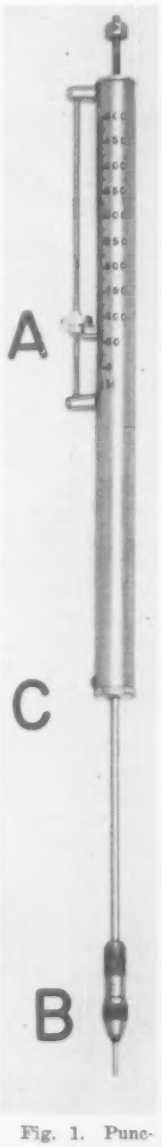


Fig. 1. Puncture meter.

Operation. A puncture test is made by holding a cherry in one hand and pressing the tip of the puncture meter against the side of the cherry; the puncture meter is held by the barrel between points A and C, in an upright position. As force is exerted against the cherry, the slider A is pushed up along the guide rod. When the tip or pin breaks through the tissue, a maximum reading in grams of force is indicated on the scale opposite the slider A. The slider is moved manually to 0 before the next cherry is tested. About 15–20 cherries can be punctured per minute.

Effect of operator. To test the effect of operator on the firmness measurements, two operators punctured the same 30 cherries once apiece. The operators alternated in making the first of the two punctures. The average for the 60 readings in this experiment was 338 g, with a range of 180–500 g. These readings showed no significant difference between operators' averages of 346 and 329 g, or between readings obtained as the first or second puncture, with averages of 326 and 349 g, respectively. The estimated standard deviation of single punctures was 53 g, whereas the variation among cherries re-

[1] Mention of names of commercial instruments and their manufacturers does not imply endorsement by the U. S. Department of Agriculture or their recommendation over other similar instruments which may be available.

Table 1. Puncture-meter average values for brined cherries in a barrel of normal firm cherries (control) and a barrel to which a pectinolytic enzyme was added to the brine (enzyme).

Hours in brine	Samples of 50			First 32 of 50		
	Average (g)	Standard deviation (g)	Standard error of average (g)	Average (g)	Standard deviation (g)	Standard error of average (g)
Control						
3	252	48	7	245	50	9
9	198	46	6	196	45	8
24	172	48	7	176	52	9
72	242	62	9	241	64	11
98	258	67	10	264	63	11
194	298	60	9	291	56	10
504	390	50	7	407	45	8
1176	387	55	8	390	58	10
2044	....	....	....	414	36	6
Enzyme						
3	230	32	5	230	34	6
9	171	35	5	165	34	6
24	187	71	10	191	76	13
72	184	73	10	183	72	13
98	238	91	13	236	86	15
194	229	70	10	234	76	14
504	222	103	15	200	94	17
1176	141	123	17	149	112	20
2044	....	....	....	76	81	14

sulted in an estimated standard deviation for single cherries with a single puncture of 67 g.

DISCUSSION

Estimating standard deviation. Estimates of the standard deviation of firmness measurements were calculated from punctures of cherries randomly drawn from each of two barrels at several time intervals. Barrel I contained normal, firm brined cherries from a commercial pack; Barrel II contained cherries identical to those of Barrel I except that an enzyme was added to the brine to induce softening of the cherries during the "curing" or brine storage period. The puncture-meter data and calculated standard deviations and standard errors are in Table 1. Where comparisons can be made, the results for 50 or for 32 cherry samples are not greatly different. The "normal," or commercially acceptable, cherries showed a marked decrease in firmness during the first 24 hours in brine, followed by a steady increase in firmness for the next 500 hours, after which period the cherries appeared to reach their "finished" texture and remain firm for months. It is possible to hold good brined cherries from one year to the next. The cherries to which the enzyme was added likewise showed a marked decrease in firmness during the first day or two in the brine; the firmness then increased measurably for several days, but soon began to decrease. These trends have been found to be characteristic of normal and of softening cherries. After about 10 days, there was a significant difference in the firmness of the cherries in the two barrels, and after 20 days, the enzyme-treated cherries were plainly too soft to use in the food products for which they are normally intended.

From these results, wherein high readings (firm cherries) are accompanied by low standard deviations, and lower readings (softening cherries) are accompanied by standard deviations of 100 or more, it appears that estimates of the mean and standard deviation would be more useful in detecting incipient softening.

Sample size for detecting change in firmness. It is of interest to detect a 50-g difference in average firmness of barrels of cherries, because a decline of 50 g at certain stages of brining, or a leveling off at too low a mean value soon after brining, may well indicate a need for remedial measures. It is assumed that the homogeneous material constitutes a barrel. A standard deviation of 50 g can be expected with firm cherries (Table 1). The two errors arising from sampling are defined as follows: Type I is the probability of stating that the difference between averages exceeds 50 g when in fact the true difference does not; and conversely, Type II is the probability of stating that the difference does not exceed 50 g when in fact it does.

We wish to assign values to the two types of error, such that both risks involved, that of misjudging good material (α) and of not detecting material which requires treatment (β), are not too large. If we assign a value to α, then β can be reduced to any desired value by an increase in the number of cherries measured. Since we do not wish to alter the brine on good lots, we set the risk of misjudging good lots at 5 times in 100. The risk of misjudging a poor lot at any one inspection may be somewhat larger since, in this particular work, additional tests will be made periodically. Table 2 gives the sample sizes required

Table 2. Sample size required [a] for detecting a 50-g difference of two puncture-meter averages with standard deviations of 50 g, and $\alpha = .05$.

Sample size (n)	Probability of Type II error, β
10	.39
15	.22
18	.15
20	.12
21	.10
25	.057
26	.049

[a] From Bennett and Franklin (1954), p. 148. Solve for the smallest value of n such that

$$\Pr(-t_\alpha - d\sqrt{n/2} < t < t_\alpha - d\sqrt{n/2}) < \beta$$

in which $d = 1$ (the ratio of the 50-g difference to the 50-g standard deviation) and $t_\alpha = 1.96$. Tables of the normal distribution are in Bennett and Franklin (1954), p. 690.

GOOD THINGS TO EAT

always taste better made with

Food Materials custom flavors

FOOD MATERIALS CORPORATION / 2521 W. 48th St., Chicago 32 • 254 W. 31st St., New York 1

The Perfect Container doesn't Just Happen!

ASK any pelican if nature didn't provide him with the perfect container for doing what it is supposed to do . . . best. Chances are he'll reply, "Brother, you said a mouthful!"

In the food field, Canco containers do what they are supposed to do . . . best! Behind every Canco success story are the experts who made it possible—Canco's aggressive team of research, manufacturing and marketing experts . . . the most experienced group in the container industry. Their knowledge of food processing and consumer needs has resulted in the leading packages of today and assures you that the great containers to come will come from Canco.

To help boost your profits, put the Canco team to work on your packaging problems.

GREAT CONTAINER IDEAS COME FROM CANCO

CANCO DIVISION

AMERICAN CAN COMPANY

Make the vanilla TASTE TEST

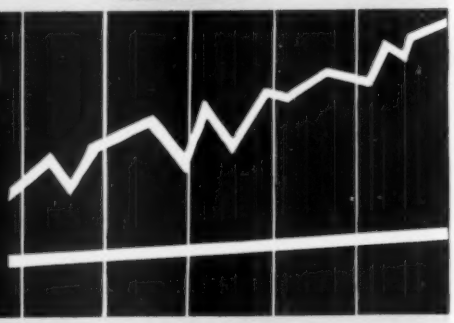
Planifoline®
(imitation vanilla concentrate)

(YOU CAN'T TELL THE DIFFERENCE)

Vanilla

Make the COST TEST

Vanilla bean costs are climbing . . . *Planifoline* (from plant extractions only) is today's quality-economy answer to your vanilla formulations . . . no artificial color added.



Florasynth
LABORATORIES, INC.

Make the taste test . . . the cost test . . . and you'll decide on *Planifoline* . . . available in one to 10-fold concentrates, oleoresins, and imitation vanilla sugars of varied strengths.

EXECUTIVE OFFICES: 900 VAN NEST AVE., (BOX 12) **NEW YORK 62,** N. Y.
CHICAGO 6 • LOS ANGELES 21
• Boston • Cincinnati • Detroit • Dallas • New Orleans
• St. Louis • San Francisco
Sales Offices in Principal Foreign Countries

for $\alpha = .05$, and different values of β (Bennett and Franklin, 1954, page 148). For example, if we are willing to allow lots that are softening to pass 15 times in 100 in the early stages of softening, a sample size of 18 would be used.

Sample size and spread. Turning our attention again to the standard deviation, it can be seen in Table 1 that the range of the standard deviation, s, for normal brined cherries was 46–67 g, and that for softening cherries was 32–123 g. At the same time, in the early stages the average firmness of the two are close. It is at this time that the spread of values (standard deviation) might be more indicative for a comparative prognostication. Assuming, as above, an average s of 50 g or less for normal cherries, we would be interested in being able to detect a value of 80 g for s. This magnitude in s is associated with the start of deterioration in texture, or softening, of brined cherries. We might then look into how well the standard deviation may be estimated if a sample size of 18 is used. Sample size required for estimating the standard deviation, expressed as a per cent of its true value, can be calculated by the method of Greenwood and Sandomire (1950). The chart given shows that for 18 cherries, the standard deviation may be estimated to within 25% of its true value with a confidence coefficient of 87%. This would appear to provide a satisfactory estimate because progressive sampling during the brine-cure period provides further verification of any change.

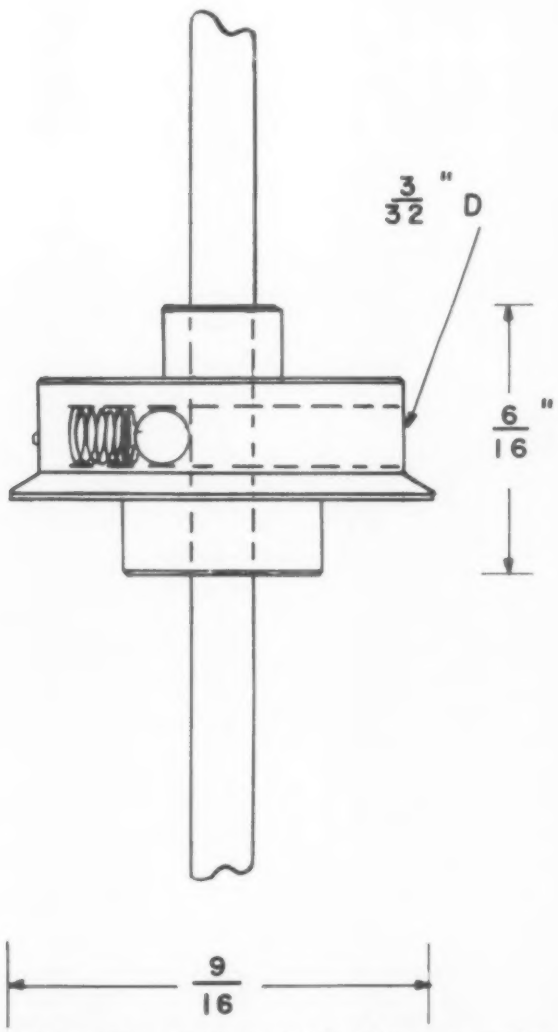


Fig. 2. Scale drawing of sliding indicator on puncture meter.

RESULTS

Relation of objective and subjective measurements. Samples of cherries of different firmness were submitted to a panel of eight men experienced in the commercial brining of cherries. The puncture-meter average values for 18 cherries and the collective comments of the panel are indicated below:

Average puncture-meter reading (g)	Collective comments
136	too soft
229	too soft
255	satisfactory
318	satisfactory
457	satisfactory

Refined statistical study of the correlation of objective and subjective estimates of firmness awaits the gathering of more planned data under conditions of commercial use of the instrument.

Application to experimental brined cherries. Considering the above, and practical aspects of the work involved in taking samples, a sample size of 18 was selected for further experimental work on barrels of brined cherries, each containing about 255 pounds of cherries. A graphical representation of the effect of pectic enzymes on the firmness of cherries in a typical experiment is seen in Fig. 3. Periodic random sampling

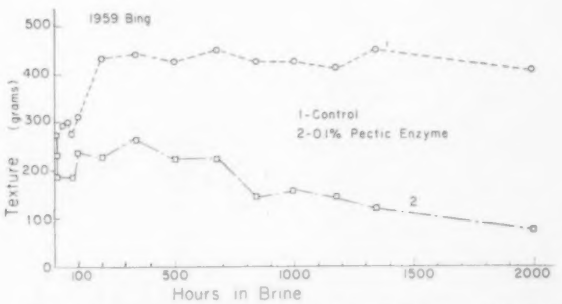


Fig. 3. Firmness measurements on brined cherries. (1) Control; firm cherries. (2) Treated with pectic enzyme; cherries became soft.

of 18 cherries from a barrel sufficed to chart the course of texture deterioration in the enzyme-treated barrel. One can see that if samples were drawn at 100-hour intervals, the difference between the barrel of normal, firm cherries and the barrel of softening cherries would be detected with a reasonable degree of confidence before 500 hours.

Application to commercial brined cherries. Several barrels of commercially brined cherries that were turning soft of apparently natural causes were tested with the puncture meter. The results can be compared to those of normal, firm, commercially brined cherries in Table 3. Eighteen cherries from each barrel were punctured. It can be seen that the average values are lower for the poor-quality (softening) cherries, and that the standard deviations are higher.

These data provide convincing evidence that the simple puncture meter described in this paper can be used effectively

Table 3. Firmness measurements on firm and softening cherries (commercially-brined). Eighteen cherries per sample.

Sample	Average meter reading (g)	Standard deviation (g)
Softening cherries		
1	139	70
2	181	87
3	231	71
4	233	108
5	273	107
Normal, firm cherries		
6	327	38
7	399	31
8	456	30
9	476	17

to provide information on the firmness of brined cherries. The meter provides: 1) a reliable objective estimate of the firmness of a given sample, and 2) a means of detecting incipient deterioration (softening).

REFERENCES

Bell, T. A., J. A. Etchells, and I. D. Jones. 1950. Softening of commercial cucumber salt-stock in relation to polygalacturonase activity. *Food Technol.* **4**, 157.

Bennett, C. A., and N. L. Franklin. 1954. Statistical Analysis in Chemistry and the Chemical Industry. John Wiley and Sons, Inc., New York.

Culpepper, C. W., and J. S. Caldwell. 1930. The canning quality of certain commercially important eastern peaches. *U. S. Dept. Agr. Bull.* **196**.

Culpepper, C. W., and C. A. Magoon. 1924. Studies upon the relative merits of sweet corn varieties for canning purposes and the relation of maturity of corn to the quality of the canner product. *J. Agr. Research* **28**(5), 403.

Greenwood, J. A., and M. M. Sandomire. 1950. Sample size required for estimating the standard deviation as a percent of its true value. *J. Am. Stat. Assn.* **45**, 257.

Lewis, C. I., A. E. Murneek, and C. C. Cate. 1919. Pear harvesting and storage investigations in the Rogue River Valley. Second report *Oregon State Coll. Agr. Expt. Sta., Sta. Bull.* **162**. July.

Rosenbaum, J., and C. E. Sando. 1920. Correlation between size of the fruit and the resistance of the tomato skin to puncture and its relation to infection with Macrosporium tomato Cooke. *Am. J. Botany* **1**, 78.

Ross, E., H. Y. Yang, and J. E. Brekke. 1958. Preliminary report on the brined cherry project. 1958 season. *Wash. State Coll. Agr. Expt. Stas., Stas. Circ.* **340**, September.

Yang, H. Y., E. Ross, and J. E. Brekke. 1959. Suggestions for cherry brining. *Oregon State Coll. Agr. Expt. Sta., Circ. of Information*, **597**, April.

Effect of Tylosin and Heat on Spoilage Bacteria in Canned Corn and Canned Mushrooms

(Manuscript received March 16, 1961)

C. B. Denny, J. M. Reed, and C. W. Bohrer

National Canners Association Research Laboratory, Washington, D.C.

SUMMARY

Quantitative recovery of *Bacillus stearothermophilus* and *Clostridium botulinum* after heating in the presence and absence of tylosin has indicated that the action of the antibiotic at 1 ppm concentration is only inhibitory. The potency of the antibiotic decreased by a factor of four during an 8-month storage period at room temperature in canned mushrooms. Results show that viable *Cl. botulinum* spores can grow and produce toxin if present in canned mushrooms when the potency of tylosin decreases after 6–8 months' storage. The data show successful experimental use of tylosin to prevent early thermophilic spoilage of canned foods given a minimum health cook (enough to destroy spores of *Cl. botulinum*).

Authors have recently presented the idea of using antibiotics in addition to sufficient heat to destroy spores of *Clostridium botulinum*, the organism of prime consideration as far as health is concerned, in the preservation of canned foods (Humphreys, 1960). This thought is of interest in that the application might eliminate spoilage of economic significance by thermophilic bacteria and allow, for certain products such as cream soups and mushrooms, a reduction in heat processes to a minimum health level, with resulting better acceptance by the consumer. This paper reports on experimental work indicating whether the use of tylosin and heat in this connection is feasible.

Preliminary laboratory screening of the antibiotic tylosin against representative spoilage types has been reported (Denny *et al.*, 1961). Because of the lack of quantitative data at the time of that publication, the action of the antibiotic could not be said to be any more than inhibitory, although spoilage was prevented in an experimental commercial pack of canned mushrooms. This paper also shows the quantitative recovery of *Bacillus stearothermophilus* and *Cl. botulinum* after heating in the presence and absence of tylosin. Data indicating inhibition were followed by experiments to show whether potency was lowered on storage and whether spores of *Cl. botulinum* would germinate if potency was lowered.

EXPERIMENTAL

Quantitative tests. *B. stearothermophilus*, No. 1518, was used in one test. Brine from cans of whole-kernel corn with a pH of 6.2 was used as the heating substrate. This brine was divided into two 100-ml lots. Tylosin was added to one of the lots to give 1 ppm. This concentration of tylosin was previously shown to be inhibitory to spores of the test suspension. Spores of No. 1518 were added to both lots and thoroughly mixed, the number being approximately 10,000 per ml. The lots were then dispensed into Pyrex tubes of 7 mm inside diameter so that each tube contained 1 ml. The tubes were sealed in an oxygen flame.

The heating methods used for comparing spore destruction rates of the test organisms were those of Esty and Williams (1924), using a constant-temperature oil bath. A temperature of 250°F was used. Due allowance was made for heat penetration lag (i.e., the time necessary for the contents of the tubes to reach the temperature of the bath). The subculture method for *B. stearothermophilus* was that described previously (Denny and Bohrer, 1959). Each tube was diluted 1:100, which had been experimentally predetermined as the point where inhibition was eliminated. The results on viable spores are an average of immediate subculture counts and subculture counts after one day at refrigerator temperature.

Cl. botulinum, No. 12885 Type A, spores were added to *M*/60 neutral phosphate buffer. The buffer solution was then divided into two equal portions and enough tylosin added to give 1 ppm in one of the portions. This concentration had been previously shown to inhibit spores of this organism.

Both portions of the inoculated buffer were tubed in 2-ml amounts in the type of tubes described above, and the tubes were sealed in an oxygen flame.

The heating procedure previously described was used with an oil-bath temperature of 230°F. Subculture was in pork agar (Reed *et al.*, 1951) in oval tubes (Miller *et al.*, 1939) layered with 2% agar. Only dilutions below the inhibitory level of tylosin were tested. Incubation was for three weeks at 85°F.

Commercial packs. The packs of stems and pieces of mushrooms have been previously described (Denny *et al.*, 1961). Incubation of the cans was for 2 months at 98°F. Control counts on the raw product were made (after heating 10 min at 228°F) on Difco dextrose tryptone agar incubated 72 hours at 98°F.

Assays on the tylosin were made by using a dilution technique with the test strain of *B. stearothermophilus* in tryptone broth tubes heated 5 min in flowing steam at 212°F. The test tubes holding the dilutions were then cooled and overlayed with sterile Vaseline. Incubation was for 2 days at 131°F.

The packs of cream-style corn were made at a commercial cannery in 300×407 cans. The tylosin was added by dissolving the appropriate amount in 100 ml of distilled water, which was added to the mixing tank where other ingredients were blended into the corn. The filler and the closing machine were run slower than usual to permit the injection of 1 ml per can of flat sour spore suspension of Nos. 1518-44, 1518-47, 1258-4, 1258-7, and 5340-12 into separate lots of 96 cans for 1-ppm and 5-ppm tests. The cans were closed and processed in a retort for a sufficient time and temperature to destroy all spores of *Cl. botulinum*. The cans were cooled to 130°F and incubated at that temperature for 30 days before being examined.

RESULTS AND DISCUSSION

The average plate recovery counts showing the heat resistance of *B. stearothermophilus*, with and without tylosin, are shown in Table 1. No apparent difference was shown by the dilution counts in the presence or absence of tylosin. This fact indicates, as previously (Denny *et al.*, 1961), that the action of 1.0 ppm tylosin is only inhibitory to spores of the test organisms.

Table 1. Heat resistance of *Bacillus stearothermophilus*, with and without tylosin in whole-kernel corn brine.

Minutes at 250°F	Av. aerobic thermophilic spore counts (per ml)	
	No tylosin	1 ppm tylosin
0	10,500	11,700
5	1,800	1,500
10	170	200
15	<16	30
20	<16	<16
25	<16	<16

The average colony recovery counts of *Cl. botulinum*, with and without antibiotic, are shown in Table 2. Again, no accelerated killing effect with this organism was demonstrated as a result of tylosin. Unlike other antibiotics, such as nisin and subtilin (O'Brien *et al.*, 1956), tylosin apparently exerts no adjuvant effect with heating. Only inhibition is demonstrated.

Table 2. Heat resistance of *Clostridium botulinum*, with and without tylosin, in neutral phosphate buffer.

Minutes at 230°F	Av. anaerobic mesophilic spore counts (per ml)	
	No tylosin	1 ppm tylosin
0	22,000,000	17,000,000
2	6,000,000	5,300,000
4	210,000	290,000
6	16,500	12,500
8	1,500	2,000
10	900	800

Tylosin stability. Tylosin has previously been shown to withstand extreme heat without losing its inhibitory powers, and an equally pertinent question is whether it will maintain its potency or inhibitory activity during long periods of storage. In the initial assays with tylosin in the mushrooms, the brine starting with 2.5 ppm on a weight-volume basis was inhibitory for 48 hours when diluted down to 0.0625 ppm. After 3½ months at 85°F in a commercially packed product, brine was inhibitory in the same procedure at 0.125 ppm. After 8 months of incubation the inhibitory level against *B. stearothermophilus* was 0.25 ppm, indicating that potency had dropped by a factor of four. Tylosin apparently loses its inhibitory properties gradually during storage.

To check this loss of potency further, tylosin was added aseptically to commercially processed cans of mushroom stems and pieces to 1 ppm. Heated spores of *Cl. botulinum* (composite strains [Denny *et al.*, 1959]) were added, and the cans were aseptically closed with solder. Incubation showed that cans without tylosin swelled and produced toxin in 3–4 days. Cans containing tylosin started swelling after 6 months, 7 months, and 8 months at 85°F. Toxin was demonstrated in these cans by tests with mice. According to the assays of potency on tylosin and the inhibition figures of *Cl. botulinum* (Denny *et al.*, 1961), this toxic spoilage should have been expected.

Commercial packs. Table 3 lists the spoilage of the previously mentioned mushroom pack at 98°F. To determine the initial spore count, an equal weight

of water and blanched stems and pieces of mushrooms were mixed thoroughly. The liquid drained from this washing of product was heated 10 minutes at 228°F, and counted. This gave a total natural flat sour spore count of 25,800 per can on the mushrooms. There were only 26 anaerobic spores per can. Tne suggested commercial heat process of 18 minutes for the 4-ounce cans gave protection against mesophilic spoilage. The reduced heat process of 10 minutes at 250°F, which is sufficient to safeguard against spoilage by health-significant spores, was not sufficient to prevent 5 cans in 100 from becoming spoiled. Two of these cans were swelled, and the remaining three were flat sour. Tylosin at 1 and 2.5 ppm was sufficient to prevent mesophilic spoilage during 2 months at 98°F.

Table 3. Mesophilic spoilage results on mushrooms (stems and pieces) with and without tylosin.

No. of cans	Process time at 250°F (min)	Tylosin (ppm)	Spoilage after 60 days at 98°F
50	18	0	0
100	10	0	5%
95	10	1	0
94	10	2.5	0

Tylosin (at 1 and 5 ppm) in experimental packs of cream-style corn inoculated with spores of thermophilic flat sour bacteria and given normal still-heat processes has prevented spoilage in 480 cans during 4 weeks at 130°F. This compares with flat sour spoilage of 461 of 480 control cans without the tylosin. These data are shown in Table 4.

Table 4. Thermophilic incubation of cream-style corn packed with and without tylosin.

Spore suspension	Spores inoculated per can	No. of cans showing spoilage after 30 days at 120°F		
		Control (no tylosin)	Tylosin (1 ppm)	Tylosin (5 ppm)
none	.....	0 of 89	0 of 96	0 of 96
1518-44	1,000	89 of 96	0 of 96	0 of 96
1518-47	1,000	94 of 96	0 of 96	0 of 96
1258-4	100,000	96 of 96	0 of 89	0 of 96
1258-7	100,000	96 of 96	0 of 96	0 of 96
5340-12	100,000	86 of 96	0 of 96	0 of 96

Thirty days at 130°F is a fairly severe test of the ability of an antibiotic to maintain inhibitory activity. Tylosin prevented growth during this period. It is known that tylosin will diminish in activity during storage at room temperature. However, it is also known (Pearce and Wheaton, 1952; Schmidt and Nank, 1957) that if certain strains of thermophilic spores can be prevented from germinating immediately after they are activated by the heat process, fewer cans will spoil if the cans are incubated at thermophilic temperatures following a storage period. The authors have observed that most of the economically significant thermophilic spoilage of canned food occurs within 4 weeks of processing, and tylosin has prevented spoilage for that period in laboratory tests.

The data indicate that if tylosin were used in canned foods, protection of the public health would still require sufficient heat processing to destroy spores of *Cl. botulinum*. The data presented, along with those previously published (Denny *et al.*, 1961), indicate that tylosin, when used with a heat process sufficient to destroy spores of *Cl. botulinum*, might prevent thermophilic spoilage of canned foods. Though heat processes on many canned foods could not be reduced by the use of tylosin, there are some products, such as mushrooms and cream soups, for which the process level might advantageously be reduced to that consistent with safeguarding health. Some canners might find it expedient to use tylosin in conjunction with the heat processes they now use if the antibiotic is approved by the Food and Drug Administration for food use.

ACKNOWLEDGMENTS

The authors thank Dr. Bernard Malin, Eli Lilly and Company, for supplying the tylosin. Also, for experimental corn-pack assistance, the authors thank Mr. Thomas Toth, Mr. Cecil Farrow, Mr. Leonard Stanislav, and Mr. Jack Welch, of the Green Giant Company, and Mr. James Berry and Dr. Bruce Morgan, of the Continental Can Company. For assistance on the experimental mushroom pack, the authors thank Mr. Howard Malick and Mr. Chester Gibson, of the Brandywine Mushroom Corporation.

The authors acknowledge the technical assistance of Dr. John Yesair in performing the heat resistance test with *Cl. botulinum*.

REFERENCES

Denny, C. B., and C. W. Bohrer. 1959. Effect of antibiotics on the thermal death rate of spores of food spoilage organisms. *Food Research* **24**, 247.

Denny, C. B., C. W. Bohrer, W. E. Perkins, and C. T. Townsend. 1959. Destruction of *Clostridium botulinum* by ionizing radiation. I. In neutral phosphate at room and freezing temperatures. *Food Research* **24**, 44.

Denny, C. B., L. E. Sharpe, and C. W. Bohrer. 1961. Effects of tylosin and nisin on canned food spoilage bacteria. *Appl. Microbiol.* **9**, 108.

Esty, J. R., and C. C. Williams. 1924. Heat resistance studies. I. A new method for determination of heat resistance of bacterial spores. *J. Infectious Diseases* **34**, 516.

Humphreys, T. W. 1960. The utilization of chemotherapeutic agents in food processing. *Can. Food Inds.* **31**, 53.

Miller, N. J., O. W. Garrett, and P. S. Prickett. 1939. Anaerobic technique—a modified deep agar shake. *Food Research* **4**, 447.

O'Brien, R. T., D. S. Titus, K. A. Devlin, C. R. Stumbo, and J. C. Lewis. 1956. Antibiotics in food preservation. II. Studies on the influence of subtilin and nisin on the thermal resistance of food spoilage bacteria. *Food Technol.* **10**, 352.

Pearce, W. E., and E. Wheaton. 1952. Autosterilization of thermophilic spores in canned foods. *Food Research* **17**, 147.

Reed, J. M., C. W. Bohrer, and E. J. Cameron. 1951. Spore destruction rate studies on organisms of significance in the processing of canned foods. *Food Research* **16**, 383.

Schmidt, C. F., and W. K. Nank. 1957. Sterilization by means of spore deactivation. *Food Research* **22**, 562.

WARNER-JENKINSON MFG. CO. RED TRADE MARK SEAL ST. LOUIS

CERTIFIED FOOD *Colors*

Tempting, eye-appeal attains its most potent sales effectiveness with Red Seal Colors of unsurpassed brilliance, purity and uniformity. Let Warner-Jenkinson produce—and precisely re-produce—the exact colors to give your products the greatest possible taste-stimulating attractiveness.

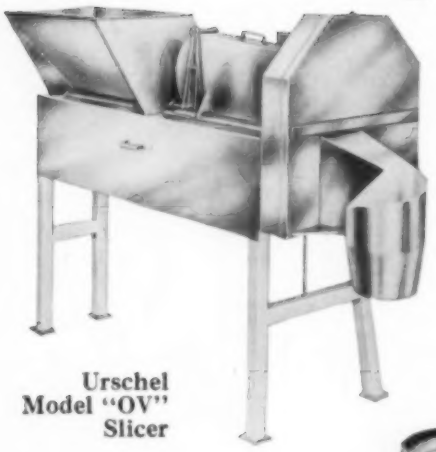
WARNER-JENKINSON MANUFACTURING CO.

Manufacturers of Certified Food Colors, Vanillas, Extracts, Flavors

2526 Baldwin St. • St. Louis 6, Mo.

West Coast: 2515 Southwest Drive, Los Angeles 43, Calif. • Warehouses: Boston, Jersey City, Atlanta

Give your product slices the *"beauty treatment"* with the Urschel high speed Model "OV" TRANSVERSE SLICER



Urschel Model "OV" Slicer

Clean, uniform, better-than-ever cross-cuts on

PICKLES
CARROTS
CELERY
RHUBARB
BROCCOLI
OKRA
SQUASH
BAMBOO SHOOTS
WATER CHESTNUTS

Plain Slices

Corrugated Slices

OPERATING PRINCIPLE

The product to be cut is dropped into a hopper through which it feeds onto two high speed conveyor belts, each sloping inwardly to form a "V" cross-section. • A third conveyor belt then comes down over the top to complete the product enclosure. • Thus, the product enters the slicing wheel completely surrounded by moving conveyor belts and slicing wheel corrugated rolls which insures its positive feed into the knives. • This action virtually eliminates plugging of the machine, and, since the feed to the knives is positive, "thin" slices occur infrequently. • The new unit is so positive in its feeding action that it will feed leafy products easily. • The "V" shape formed by the belts keeps the product in constant alignment with the cutting knives regardless of product diameter, practically eliminating "bias" cuts.

- ***Positive*** **feed action.**
- **No product crushing.**
- **Practically eliminates "thin" or "bias" cuts.**
- **Cuts thicknesses from 1/16" to 1-1/3".**
- **High capacity feeding with maximum cutting yield.**
- **Compact—engineered for long dependable service and low maintenance.**

URSCHEL LABORATORIES INC.
VALPARAISO, INDIANA

Designers and manufacturers of precision, high speed cutting equipment for food products

340B

Quality of Frozen Vegetables Purchased in Selected Retail Markets

J. P. Sweeney, V. J. Chapman, M. E. Martin, and E. H. Dawson

Human Nutrition Research Division, Agricultural Research Service, U. S. Department of Agriculture, Washington 25, D.C.

(Manuscript received November 4, 1960)

SUMMARY

An investigation was made of the quality of frozen green vegetables, both as received from the local retail market and after cooking. Brussels sprouts, broccoli spears, cut green beans, green peas, Fordhook lima beans, and leaf spinach were studied. Selected brands of the vegetables were purchased from selected stores, and each brand-store combination was repeated four times for four consecutive seasons. Ascorbic acid content and ratio of oxidized to reduced ascorbic acid varied considerably in all vegetables. Color was also variable among samples. Cooking of the vegetables accelerated ascorbic acid and chlorophyll changes that had begun in the uncooked vegetables. In the cooked vegetables, texture and flavor scores covered a wide range of the rating scale.

THE CONSUMPTION of frozen fruits and vegetables has increased rapidly in recent years. In 1959 the commercial pack of these products (excluding citrus juice concentrates) exceeded 2.2 billion pounds, about double the 1950 pack (National Association of Food Packers, 1960).

Information on the quality of frozen food purchased by the consumer is therefore of vital interest. The effects of time and storage temperature on the quality of fresh-frozen food have been investigated extensively. The Western Utilization Laboratories of the Agricultural Research Service have carried out time-temperature tolerance studies of frozen fruits and vegetables obtained directly from the processor (Van Arsdel, 1957). The nutrient content of frozen vegetables has been studied by the Wisconsin Alumni Research Foundation (Burger *et al.*, 1956; Derse and Teply, 1958; Teply and Derse, 1958). The study covered vegetables obtained directly from the processor and tested, both cooked and uncooked, after storage under predetermined conditions of time and temperature.

Comparatively little work has been done on the quality of frozen vegetables from retail market channels. Kelsey (1956) pointed out that high temperatures during transport and storage, at warehouses and in retail store storage rooms and retail cabinets, harm frozen-food quality. Quality evaluations made on five vegetables secured from six retail markets in Brookings, South Dakota, have been reported by the South Dakota Agricultural Experiment Station (Burrill and Alsup, 1957).

To augment the limited information available, the quality of six frozen vegetables from selected retail markets was studied in four seasons in the Washington (D. C.) area. Since the number of brands and stores sampled was limited, the results do not necessarily represent other brands, stores, or localities.

EXPERIMENTAL METHODS

Materials. The frozen vegetables selected for investigation were among those packed in the largest quantities (Almanac of the Frozen Food Industry, 1958): cut green beans, lima beans, broccoli spears, brussels sprouts, green peas, and leaf spinach. The vegetables, in 9- to 10-oz family-sized packages, were purchased once each week from three retail markets, simulating habits of the homemaker. They were packed in Fiberglas-insulated bags for transport directly to the laboratory and were stored at −8° to −12°F until used (never longer than one week after purchase). For comparison, samples obtained directly from a processor were also tested.

Design. The work was carried out according to a randomized block design (Cochran and Cox, 1957), specifying the order of cooking and testing the samples. Variables investigated were brand, store, and season. Selected brands of each vegetable (four for brussels sprouts and three for each of the other vegetables) were purchased from stores under different managements and having high-volume sales. Three stores were used for brussels sprouts and two for each of the other vegetables. Four samples were studied per day, one for each brand-store combination of a single vegetable. Each brand-store combination was replicated four times each season for four consecutive seasons.

Quality measurements. Because of the large number of samples involved it was necessary to select quality tests that could be carried out in a short time. Research of the Western Utilization Laboratories (Dietrich *et al.*, 1957) has revealed that frozen vegetables stored above 0°F lose ascorbic acid and chlorophyll and change color and flavor. Guerrant (1957) reported changes in light reflectance and ascorbic acid content of foods during frozen storage. Of particular importance as measures of quality are the ratio of dehydroascorbic acid plus diketogulonic acid to reduced ascorbic acid and the percentage conversion of chlorophyll to pheophytin (Dietrich *et al.*, 1957). In a frozen vegetable properly blanched and stored at 0°F or lower, the ratio of oxidized to reduced ascorbic acid should be very low. Above 0°F, reduced ascorbic acid oxidizes to dehydroascorbic acid and diketogulonic acid, increasing the ratio. The amount of increase indicates the extent of storage above 0°F.

A vegetable that has been properly blanched and stored at 0°F should also retain most of its chlorophyll. Above 0°F, chlorophyll is converted to pheophytin. Dietrich *et al.* (1959), from work with green beans, reported that the rate of conversion above 0°F varies directly with the amount of conversion that took place during blanching. Poor chlorophyll retention could therefore be due to improper blanching, to storage at temperatures above 0°F, or to a combination of both factors. Changes in quality would also be reflected by changes in texture.

Accordingly, the tests selected for measuring quality were: panel evaluations of color, texture, and flavor; reflected color as measured by color difference meter; texture, as measured by shear press; reduced ascorbic acid, dehydroascorbic acid, and diketogulonic acid; and the percentage of chlorophyll and pheophytin.

Preparation and cooking. Seven packages of each brand of vegetable were removed from the freezer and opened. Those to

be tested uncooked were allowed to thaw at room temperature (about 1 hour).

The packages were allotted as follows: the contents of two packages of uncooked vegetable were mixed and used for color-difference-meter and shear determinations. One additional package of uncooked vegetable was used for ascorbic acid and chlorophyll determinations. The contents of two packages were cooked, mixed, and used for determination of ascorbic acid, chlorophyll, and shear strength, and two additional packages of cooked vegetable were pooled for color-difference-meter readings and panel evaluations of color, texture, and flavor.

The samples to be cooked were weighed. A predetermined amount of distilled water (177 g for spinach, lima beans, brussels sprouts, and broccoli; 118 g for peas; 236 g for green beans) was brought to a boiling temperature as determined by thermocouple in each of four 4-quart glass-covered saucepans. The frozen vegetable (18 oz for green beans, 20 oz for the other vegetables) was placed in the boiling water, and timing was begun when the water returned to boiling. The vegetables were cooked until tender; cooking times are given in Table 1. They were then weighed and drained, and weights of drained vegetable and liquid were recorded separately. The samples used for chemical determinations were cooked to 75°F and reweighed. Those for the panel were served immediately.

Panel scoring. Color, flavor, and texture of the cooked vegetables were rated by a trained panel of five members. Warm coded samples were presented to the panel for quality rating and for detection of any off-flavor (Gilpin *et al.*, 1959). The rating scales for each factor are given in the footnotes of Tables 2, 5, and 7.

Color. Reflected color was measured with a Gardner Automatic Color Difference Meter (Gardner Automatic Color Difference Meter Bull.). A Gardner medium-green color standard was used: L 50.0; $a_L - 25.7$; $b_L + 7.3$. The average of five readings was taken as the color value of the sample. The readings were expressed as the ratio a_L/b_L. Chlorophyll was determined by a modification of the procedure of Mackinney and Weast (Mackinney and Weast, 1940; Sweeney and Martin, 1958).

Shear force. A Lee-Kramer Shear Press (Kramer *et al.*, 1951) with a standard cell and a 3000-lb proving ring was used for each raw and cooked sample. Only the stems of broccoli were tested; the other vegetables were used untrimmed.

Ascorbic acid. Ascorbic acid was determined only in the vegetable solids. The procedure of Bessey and King (1933) was used for the reduced form of the vitamin. The samples were extracted by a procedure reported for broccoli (Sweeney *et al.*, 1959). The presence of reductones was checked by the procedure of Robinson and Stotz (1945). Dehydroascorbic acid plus diketogulonic acid was determined by reaction with 2,4-dinitrophenylhydrazine, using a modification of the procedure described by Roe *et al.* (1948). To 20 ml of the extract were added 2 g thiourea and 10 ml 10% HPO_3, and the solution was diluted to volume with 5% HPO_3. For the preparation of standards, 100 mg of ascorbic acid was diluted to 100 ml with 5% HPO_3. Fifty ml of this solution was oxidized with bromine, and the excess bromine removed by aeration. To 5 ml of this solution was added 2.5 g thiourea, and the mixture was diluted to 250 ml with 5% HPO_3 for the preparation of standard solutions. The remainder of the determination was carried out as described by Roe *et al.* (1948). Since dehydroascorbic acid and diketogulonic acid were not differentiated, the use of H_2S was not necessary. Tewari and Krishnan (1961) have reported losses of ascorbic acid in samples treated with H_2S.

Evaluation of data. Data on all quality characteristics of cooked and uncooked vegetables were evaluated by analysis of variance. The mean square for error was used in computing coefficients of variation (Snedecor, 1956). Differences between means were tested for significance by the method of Duncan and Bonner (1954).

RESULTS AND DISCUSSION

Table 1 shows mean values and ranges for the quality factors investigated. Shown for comparison are results on samples received directly from a processor. Detailed information on the background of his samples was supplied by the processor. However, they were of a brand not sampled in the retail market. Only two replications were made on each vegetable obtained from the processor except for broccoli. Data on fifteen replications are available on broccoli since it was investigated in work on another project. The results on the processor samples are therefore not necessarily typical of those to be expected on processor samples from other sources. They are of interest, however, since in most cases they do not differ greatly from mean values obtained on samples from the retail market.

Uncooked vegetables. There were wide ranges in ascorbic acid content and in the ratio of oxidized to reduced ascorbic acid. Color was also variable, as shown by chlorophyll conversion and color difference meter values. Shear force values covered a broad range.

Each of the vegetables behaved differently in regard to the quality factors investigated. There appeared to be differences among vegetables in extent to which ascorbic acid was oxidized. The average ratio in broccoli was 0.16, compared to 0.54 in green beans. For spinach the oxidation ratio ranged from 0.06 to 4.22, with a coefficient of variation of 142. A few extremely high values were responsible for much of the variation in this vegetable. The vegetables also differed in percentage conversion of chlorophyll. The mean value was 10% for spinach and green peas, compared to 31% for brussels sprouts and 23% for green beans. Since chlorophyll is known to be more stable in spinach and green peas than in green beans and brussels sprouts, it is likely that these values reflected, to a considerable extent, differences in the vegetables rather than differences in storage conditions.

The mean ascorbic acid values were similar to those reported in the Wisconsin study on samples received directly from a processor (Table 2). The ranges in ascorbic acid values reported by Wisconsin were quite large, but not as great as those obtained for the Washington retail market samples.

Cooked vegetables. There were large losses in ascorbic acid and chlorophyll in the cooked vegetables. As with the uncooked vegetables, objective quality factors varied over a wide range. Panel evaluations of color, texture, and flavor also indicated considerable variations. The percentage of off-flavor judgments ranged from 26% in green peas, to 36% in lima beans and brussels sprouts.

In general, the mean values for the retail market samples, both cooked and uncooked, did not differ greatly from those for samples obtained directly from a processor. Ascorbic acid oxidation ratios were, however, somewhat higher for the retail market samples. However, because of the low initial ascorbic acid content of green beans, lima beans, and green peas, slight differences in the oxidized ascorbic acid content of these vegetables could cause considerable differences in their oxidation ratios.

Effect of season on ascorbic acid, chlorophyll conversion, and flavor. As to chlorophyll conversion, lima

Table 1. Quality of frozen vegetables from retail markets in Washington, D. C., and directly from processors.

Vegetable	Uncooked					Cooked									
	AsA[a]	DH + DK[b] / AsA	Chlorophyll conversion (pheophytin)	Color difference meter	Mean shear values	AsA[a]	AsA[a] retention	Chlorophyll conversion (pheophytin)	Color difference meter	Mean shear values	Mean panel scores for: Color[c]	Texture[d]	Flavor[e]	Cooking time	Off-flavor judgments
	mg/100 g		%	a_L/b_L values	lb force	mg/100 g	%	%	a_L/b_L values	lb force				min	%
Beans, green															
Processor															
Mean[f]	6	0.41	21	0.92	334	4	67	63	0.58	65	4.2	4.6	3.7	11	20
Range	....	....	19–23	0.91–0.92	328–340	36–42		63–64	0.57–0.58	....	4.0–4.4	4.2–5.0	3.4–4.0		
Retail market															
Mean[g]	9	0.54	23	0.92	723	6	67	73	0.49	91	3.5	5.1	3.5	16	28
Range	3–20	0.14–1.71	0–53	0.48–1.05	512–890	2–12		59–90	0.31–0.69	8–172	1.8–4.8	3.6–6.4	1.4–4.4	11–22	
C.V.[h]	33	50	39	10	12	28		7	11	22	14	9	13		
Beans, lima (Fordhook)															
Processor															
Mean	19	0.22	22	0.63	390	14	74	67	0.40	148	3.6	4.0	3.6	14	50
Range	18–20	0.21–0.24	22–23	0.62–0.64	....	13–14		65–68	0.38–0.43	143–152	....	....	....		
Retail market															
Mean	17	0.35	28	0.59	390	12	71	60	0.42	170	3.0	4.5	3.5	13	36
Range	10–24	0.12–0.93	0–48	0.42–0.70	280–490	4–17		32–83	0.26–0.52	65–290	1.4–4.6	3.0–6.4	1.6–5.0	10–18	
C.V.	12	30	26	8	10	11		14	16	25	28	15	26		
Broccoli spears															
Processor															
Mean	83	0.06	11	0.89	1618	66	80	57	0.57	257	3.6	4.5	3.3	12	30
Range	81–84	0.05–0.07	4–17	0.86–0.97	1515–1653	61–69		44–60	0.54–0.60	208–446	3.0–5.0	4.3–4.7	3.1–3.6	10–15	
Retail market															
Mean	68	0.16	19	0.83	1590	48	71	55	0.59	308	3.8	4.7	3.4	12	32
Range	38–93	0.06–0.40	0–38	0.67–1.01	680–2230	28–66		40–66	0.45–0.79	123–582	2.4–5.0	2.8–6.2	2.0–4.8	9–17	
C.V.	13	29	23	7	19	16		10	10	34	14	11	14		
Brussels sprouts															
Processor															
Mean	70	0.16	32	0.49	720	51	73	78	0.21	122	2.8	4.5	3.5	16	30
Range	64–75	0.13–0.20	30–33	0.48–0.50	670–770	48–54		77–80	0.20–0.21	113–132	2.8	4.4–4.6	3.2–3.8		
Retail market															
Mean	79	0.20	31	0.42	531	59	75	79	0.22	103	3.2	4.6	3.2	13	36
Range	50–122	0.11–0.55	0–48	0.24–0.67	280–855	33–90		69–88	0.13–0.35	8–247	2.2–4.2	3.0–6.0	2.0–4.6	10–17	
C.V.	13	30	19	24	17	18		5	18	40	14	10	15		
Peas, green															
Processor															
Mean	18	0.17	13	0.89	480	13	68	44	0.67	320	4.5	5.5	3.9	12	00
Range	18–19	0.16–0.18	12–14	0.86–0.91	....	13		43–44	0.66–0.68	270–371	4.4–4.6	5.4–5.6	3.8–4.0		
Retail market															
Mean	18	0.30	10	0.95	440	12		32	0.77	182	4.2	4.9	3.8	10	26
Range	8–24	0.11–1.01	0–23	0.88–1.04	340–542	4–19	67	16–48	0.63–0.91	27–340	2.8–5.0	3.6–6.4	2.4–4.8	5–16	
C.V.	16	37	40	2	9	17		20	5	33	9	12	15		
Spinach															
Processor															
Mean	39	0.42	2	1.07	684	22	56	19	0.97	142	4.1	4.2	3.6	10	20
Range	34–44	0.37–0.47	0–5	1.05–1.09	699–670	....		18–20	0.81–1.1	132–102	4.0–4.3	4.0–4.4	3.2–4.0		
Retail market															
Mean	34	0.36	10	1.10	586	20	59	23	1.00	180	4.3	4.5	3.4	9	32
Range	6–65	0.06–4.22	0–29	0.92–1.26	172–1170	4–43		2–43	0.75–1.18	38–381	2.8–5.0	2.8–6.6	1.2–4.8	5–14	
C.V.	37	142	50	6	31	34		25	8	29	8	16	20		

[a] Reduced ascorbic acid.

[b] Ratio of dehydroascorbic acid plus diketogulonic acid to reduced ascorbic acid.

[c] Mean of 5 values on each sample. A score of 5 denotes bright green; 4, moderately bright green; 3, slightly dull green; 2, dull yellow green; 1, dark brownish green.

[d] Mean of 5 values on each sample. A score of 9 denotes very tough; 8, tough; 7, moderately tough; 6, slightly too firm; 5, tender yet firm; 4, slightly too tender; 3, moderately soft; 2, soft; 1, mushy.

[e] Mean of 5 values on each sample. A score of 5 denotes natural, full flavor; 4, slightly lacking in natural flavor; 3, moderately full; 2, moderately weak; 1, weak or lacking.

[f] Values for samples from processor are mean of 2 replications, except for broccoli. Broccoli values are mean of 15 replications.

[g] Values for samples from retail market are mean of 64 samples.

[h] Coefficient of variation.

Table 2. Ascorbic acid in samples from retail stores in Washington, D. C., and from Wisconsin processors.

Vegetable	Washington		Wisconsin	
	mean [a]	range	mean	range
	mg/100 g	mg/100 g	mg/100 g	mg/100 g
Beans, green	9	3– 20	7	1– 13
Beans, lima	17	10– 24	20	16– 25
Broccoli spears	68	38– 93	75	59–102
Brussels sprouts	79	50–122	82	68– 98
Peas, green	18	8– 24	17	10– 23
Spinach	34	6– 65	32	10– 46

[a] Values are mean of 64 samples.

Table 3. Effect of season on chlorophyll conversion (%) in frozen vegetables from retail markets in Washington, D. C.[a]

Season	Beans, green	Beans, lima	Broccoli, spears	Brussels sprouts	Peas, green	Spinach, leaf
Winter	19	21	16	24	9	8
Spring	20	30	18	29	9	12
Summer	30	32	25	38	12	9
Fall	25	28	14	33	11	11
Test difference[b]	12	10	6	8	5	7

[a] Values are mean of 16 samples of vegetables as received.
[b] The difference between 2 means is significant at the 5% level when it equals or exceeds the test difference.

beans were significantly higher in summer than in winter (Table 3). Broccoli was significantly higher in summer than in the other three seasons. Brussels sprouts were significantly higher in summer than in winter or spring, and higher in fall than in winter. Ascorbic acid in contrast, showed only one significant difference that could be related to season: in lima beans it was lower in spring and summer than in winter. Flavor did not differ significantly by season. In general, vegetables purchased in summer tended to be highest in chlorophyll conversion. This was particularly true of broccoli and brussels sprouts and may reflect a longer storage period between packing and sale for these two vegetables.

Effect of brand on ascorbic acid, chlorophyll conversion, and flavor. Ascorbic acid in brussels sprouts was significantly higher for Brand B, Store 1, than for each of the other brand-store combinations (Table 4). In green beans, ascorbic acid was higher for Brand B, Store 1, and Brand C, Store 2 than for Brand A, Store 1, or Brand B, Store 2. In lima beans, it was higher for Brand C, Store 2, than for Brand B, Stores 1 or 2. Chlorophyll conversion in green beans was significantly higher for Brand A, Store 1, than for Brand B from the same store. There were no other significant differences in reduced or oxidized ascorbic acid, chlorophyll conversion, or panel flavor scores that could be related to brand or store of purchase.

Comparison of between-sample variations with variations within samples. The relationship of sample variation to experimental error or variation within samples was investigated for ascorbic acid, dehydroascorbic acid plus diketogulonic acid, color-difference meter, chlorophyll conversion values, and panel scores for color, texture, and flavor. The calculated values for within-sample variation represent both experimental error and variation because of lack of sample uniformity.

Table 4. Effect of brand on ascorbic acid and pheophytin content of frozen vegetables from retail markets in Washington, D. C.[a]

Vegetable	Brand[b]	Store[b]	AsA[c]	Chlorophyll conversion (pheophytin)
			(mg/100 g)	%
Beans, green	A	1	7	30
	B	1	11	15
	B	2	7	25
	C	2	11	24
Test difference[d]			4	12
Beans, lima Fordhook	A	1	17	29
	B	1	16	28
	B	2	16	27
	C	2	19	25
Test difference			3	10
Broccoli spears	A	1	67	18
	A	2	66	19
	B	2	70	18
	C	1	68	20
Test difference			12	6
Brussels sprouts	A	1	75	35
	B	1	96	29
	C	2	75	30
	D	3	70	30
Test difference		14	8	8
Peas, green	A	1	17	11
	B	1	19	9
	B	2	16	12
	C	2	19	8
Test difference			4	5
Spinach, leaf	A	1	28	10
	A	2	33	8
	B	2	41	12
	C	1	35	10
Test difference			17	7

[a] Each value is mean of 16 samples.
[b] The brand-store codes are not identical for each vegetable.
[c] Reduced ascorbic acid.
[d] The difference between 2 means is significant at the 5% level when it equals or exceeds the test difference.

The results, except for chlorophyll conversion, are in Table 5. The test differences for within-sample variation were, in each case, lower than were the corresponding test differences for the interaction term. The between-sample variation therefore might be partially accounted for by variation within samples.

In determination of within-sample variability for chlorophyll conversion, fresh vegetables were used rather than frozen since it was believed that they might be more uniform (Table 6). Because of the difficulty in obtaining vegetables with uniform chloro-

Table 5. Variation within samples as compared to variation between samples.

Frozen vegetable	Characteristic	Test difference	
		Based on variation within sample	Based on interaction term[a]
Peas, green[b]	AsA (mg/100 g)	1.0	5.1
Spinach, leaf[c]	AsA (mg/100 g)	0.7	21.9
Spinach, leaf[d]	AsA (mg/100 g)	2.5	
Peas, green[e]	DH + DK (mg/100 g)	0.6	2.6
Spinach, leaf[e]	DH + DK (mg/100 g)	0.7	10.8
Peas, green[f]	a_L/b_L	0.02	0.04

[a] Interaction of brand × season or brand × season × replication.
[b] Statistical analysis based on duplicate determinations on 16 packages in each of 3 seasons (summer, winter, and spring).
[c] Based on 2 seasons (winter and spring).
[d] Based on summer season.
[e] Triplicate determinations made on 4 packages in each of 4 seasons.
[f] Based on 5 determinations on each of 4 packages from each of 4 seasons.

Table 6. Variation within samples for chlorophyll conversion (%)[a] in fresh vegetables.

Vegetable	Mean chlorophyll conversion	Standard deviation	95% confidence limits for mean
Beans, green	2.3	1.96	0.4– 4.2
Broccoli	10.7	4.01	7.3–14.1
Brussels sprouts	43.0	2.10	41.2–44.8
Peas, green	5.8	2.27	3.9– 7.7
Spinach, leaf	7.2	4.44	3.5–10.9

[a] Mean values based on 8 replications made on a single lot of each vegetable, except green beans. Value for green beans is mean for 7 replications.

phyll conversion values, however, it is likely that the major proportion of the within-sample variation was due to lack of sample uniformity rather than experimental error.

In the case of panel scores, test differences based on variation of judges' scores about the panel mean were, for each vegetable, higher than were the corresponding test differences based on the interaction term.

ACKNOWLEDGMENTS

The authors thank Mr. J. N. Eisen, for help in design of experiments and statistical analysis of the results, and Mrs. B. M. Minnick, Miss P. L. King, and Mrs. A. R. Cusick for technical assistance.

REFERENCES

Almanac of the Frozen Food Industry. 1958. *Quick Frozen Foods* **20**, 185.

Bessey, O. A., and C. G. King. 1933. The distribution of vitamin C in plant and animal tissues and its determination. *J. Biol. Chem.* **103**, 687.

Burger, M., L. W. Hein, L. J. Teply, P. H. Derse, and C. H. Krieger. 1956. Vitamin, mineral and proximate composite of frozen fruits, juices and vegetables. *J. Agr. Food Chem.* **4**, 418.

Burrill, L. M., and B. Alsup. 1957. You can expect good quality when you buy frozen vegetables. *S. Dakota Farm Home Research* **9**, 3.

Cochran, W. G., and G. M. Cox. 1957. "Experimental Designs." 2nd ed. John Wiley and Sons, Inc., N. Y.

Derse, P. H., and L. J. Teply. 1958. Frozen food storage effects. Effect of storage conditions on nutrients in frozen green beans, peas, orange juice, and strawberries. *J. Agr. Food Chem.* **6**, 309.

Dietrich, W. C., F. E. Lindquist, J. C. Miers, G. S. Bohart, H. J. Newmann, and W. F. Talburt. 1957. The time-temperature tolerance of frozen foods. IV. Objective tests to measure adverse changes in frozen vegetables. *Food Technol.* **11**, 109.

Dietrich, W. C., M. D. Nutting, R. L. Olson, F. E. Lindquist, M. M. Boggs, G. S. Bohart, H. J. Newmann, and H. J. Morris. 1959. Time-temperature tolerance of frozen foods. XVI. Quality retention of frozen green snap beans in retail packages. *Food Technol.* **13**, 136.

Duncan, D. B., and R. G. Bonner. 1954. Simultaneous confidence intervals derived from multiple range and multiple F Test. *Virginia Agr. Expt. Sta. Tech. Rept.* **10**a.

Gardner Automatic Color Difference Meter Bull. 156, Bethesda, Md. Gardner Lab. n.d.

Gilpin, G. L., J. P. Sweeney, V. J. Chapman, and J. N. Eisen. 1959. Effect of cooking methods on broccoli. II. Palatability. *J. Am. Dietet. Assoc.* **35**, 359.

Guerrant, N. B. 1957. Food storage effects. Changes in light reflectance and ascorbic acid content of foods during frozen storage. *J. Agr. Food Chem.* **5**, 207.

Kelsey, R. J. 1956. Frozen quality—how protect it? *Food Eng.* **28**, 50.

Kramer, A., G. J. Burkhardt, and H. P. Rogers. 1951. The shear press, a device for measuring food quality. *Canner* **112**, 34.

Mackinney, G., and C. A. Weast. 1940. Color changes in green vegetables. *Ind. Eng. Chem.* **32** (3), 392.

National Association of Frozen Food Packers. 1960. Frozen food packers statistics. March 31.

Robinson, W. B., and E. Stotz. 1945. The indophenol-xylene extraction method for ascorbic acid and modifications for interfering substances. *J. Biol. Chem.* **160**, 217.

Roe, J. H., M. B. Mills, M. J. Osterling, and C. M. Damron. 1948. The determination of diketo-l-gulonic acid, dehydro-l-ascorbic acid and l-ascorbic acid in the same tissue extract by the 2,4-dinitrophenylhydrazine method. *J. Biol. Chem.* **174**, 20.

Snedecor, G. W. 1956. "Statistical Methods." 5th ed. Iowa State College Press, Ames, Iowa.

Sweeney, J. P., and M. E. Martin. 1958. Determination of chlorophyll and pheophytin in broccoli heated by various procedures. *Food Research* **23**, 635.

Sweeney, J. P., G. L. Gilpin, M. G. Staley, and M. E. Martin. 1959. Effect of cooking methods on broccoli. I. Ascorbic acid and carotene. *J. Am. Dietet. Assoc.* **35**, 354.

Teply, L. J., and P. H. Derse. 1958. Nutrients in cooked frozen vegetables. *J. Am. Dietet. Assoc.* **34**, 836.

Tewari, C. P., and P. S. Krishnan. 1961. Loss of ascorbic acid during estimation by the Roe-Kuether method. *Food Sci.* **26**, 11.

Van Arsdel, W. B. 1957. The time-temperature tolerance of frozen foods. I. Introduction—the problem and the attack. *Food Technol.* **11**, 28.

Directory

INSTITUTE OF FOOD TECHNOLOGISTS

President
HAROLD W. SCHULTZ
Dept. of Food & Dairy Technology
Oregon State University
Corvallis, Oregon

President-Elect
JOHN M. JACKSON
American Can Company
Research Center
Barrington, Illinois

Executive Secretary
CALVERT L. WILLEY
176 W. Adams Street
Chicago 3, Illinois

Assistant Executive Secretary
MARIAN A. GILCHRIST
176 W. Adams Street
Chicago 3, Illinois

Treasurer
ARTHUR N. PRATER
Gentry Division
Consolidated Foods Corp.
P. O. Box 1471
Glendale 5, Calif.

Assistant Treasurer
W. RAY JUNK
California & Hawaiian Sugar Ref. Corp.
215 Market Street
San Francisco 5, Calif.

Executive Committee of the Council

H. W. Schultz, I. J. Hutchings, J. M. Jackson, A. N. Prater, S. L. Galvin, C. A. Greenleaf, J. H. Kilbuck, H. E. Robinson, L. B. Sjostrom, W. R. Roy.

Councilors-at-Large

Terms Expire 1962: G. M. Dack, E. M. Mrak, L. B. Sjostrom, C. K. Wiesman.
Terms Expire 1963: C. A. Greenleaf, H. Lineweaver, R. T. Milner, H. E. Robinson.
Terms Expire 1964: H. A. Campbell, G. E. Felton, J. T. R. Nickerson, W. R. Roy.

REGIONAL SECTION CHAIRMEN, SECRETARIES AND COUNCILORS

CHICAGO, No. 1: Chairman, D. A. Huber. Secretary, James J. Albrecht, Accent International, Old Orchard Road, Skokie, Ill. Councilors, L. G. Buettner, G. A. Crapple, J. W. Evans, H. P. Furgal, J. W. Hanley, D. A. Huber, H. H. Mottern, D. W. Riester.

NORTHERN CALIFORNIA, No. 2: Chairman, B. A. Filice. Secretary, Dave Eolkin, Gerber Products Co., 9401 San Leandro St., Oakland 3, Calif. Councilors, B. Grossi, J. H. Kilbuck, C. Smith, C. T. Townsend.

NORTHEAST, No. 3: Chairman, J. T. R. Nickerson. Secretary, Donald E. E. Westcott, W. R. Grace & Co., Cryovac Div., 62 Whittemore Ave., Cambridge 40, Mass. Councilors, E. E. Anderson, J. J. Licciardello.

SOUTHERN CALIFORNIA, No. 4: Chairman, C. Miller. Secretary, Robert H. Henderson, Adolph's Food Products, 1800 W. Magnolia Ave., Burbank, Calif. Councilors, M. Appleman, C. G. Beisel, H. M. Espoy.

ST. LOUIS, No. 5: Chairman, J. C. Fruin. Secretary, A. Charles Roland III, Roland Industries Inc., 3517 Gratiot St., St. Louis 3, Mo. Councilor, L. J. Ahlberg.

NEW YORK, No. 6: Chairman, D. Melnick. Secretary, Enio Feliciotti, Thomas J. Lipton, Inc., 1500 Hudson St., Hoboken, N. J. Councilors, A. Astrack, R. R. Barton, E. M. Crozier, S. L. Galvin, N. H. Ishler, R. E. Morse, B. L. Oser, E. F. Stier.

FLORIDA, No. 7: Chairman, C. H. Brokaw. Secretary, Herman L. Jones, 305 Lake Summit Drive, Winter Haven, Fla. Councilor, W. G. Enns.

WESTERN NEW YORK, No. 8: Chairman, J. C. Moyer. Secretary, Claude W. Bice, The R. T. French Company, 1 Mustard St., Rochester, N. Y. Councilor, F. A. Lee.

GREAT LAKES, No. 9: Chairman, I. J. Pflug. Secretary, Mary Morr, Home Economics Bldg., Michigan State Univ., East Lansing, Mich. Councilor, F. J. Erickson.

PHILADELPHIA, No. 10: Chairman, F. B. Jacobson. Secretary, Murray I. Cooper, Insect Control & Research, 2635 Mt. Carmel Ave., Glenside, Pa. Councilor, R. H. Jacobsen.

MARYLAND, No. 11: Chairman, W. E. Anderson. Secretary, Albert J. Karas, McCormick & Co., Inc., 414 Light St., Baltimore 2, Md. Councilor, A. Kramer.

PUGET SOUND, No. 12: Chairman, L. G. Germain. Secretary, Wayne Tretsven, U. S. Bureau of Commercial Fisheries, 2725 Montlake Blvd., Seattle 2, Wash. Councilor, R. M. Way.

AMES, No. 13: Chairman, W. W. Marion. Secretary, Frances Carlin, Food Processing Bldg., Iowa State University, Ames, Ia. Councilor, W. L. Brown.

MOHAWK VALLEY, No. 14: Chairman, J. C. Barlow. Secretary, Linda M. Dulin, Beech-Nut Lifesavers, Inc., Canajoharie, N. Y. Councilor, T. F. Irmiter.

OHIO VALLEY No. 15: Chairman, N. M. Spain. Secretary, Wilbur A. Gould, Ohio State Univ., Hort. Dept., Columbus, Ohio. Councilor, R. F. Robinson.

OREGON, No. 16: Chairman, J. T. Yolland. Secretary, John B. Dilworth, Jr., 1309 N.E. 64th St., Vancouver, Wash. Councilor, R. M. Averill.

DIXIE, No. 17: Chairman, A. J. Shingler. Secretary, Cordelia A. Ellis, Georgia Experiment Station, Experiment, Ga. Councilor, C. C. Lovvorn.

TEXAS, No. 18: Chairman, R. D. Wende. Secretary, Ethel Chapman, 4409 Mt. Vernon St., Houston, Texas. Councilor, I. I. Peters.

AUSTRALIA NORTHERN, No. 19: Chairman, J. J. David. Secretary, Peter M. Crocker, Albright & Wilson (Aust) Pty. Ltd., 486 Pacific Highway, St. Leonards, N.S.W., Australia. Councilor, J. F. Williams.

INDIANA, No. 20: Chairman, G. M. Clark. Secretary, Gordon E. Wilhite, Dept. of Horticulture, Purdue Univ., West Lafayette, Ind. Councilor, L. F. Rutledge.

PITTSBURGH, No. 21: Chairman, D. T. Maunder. Secretary, Harry J. Lipman, Mallet & Co., Inc., Box 474, Carnegie, Pa. Councilor, R. E. Buck.

BRITISH COLUMBIA, No. 22: Chairman, C. Bullen. Secretary, David K. Payne, Taylor Instrument Companies of Canada, Ltd., 1807 Fir St., Vancouver 9, B. C., Canada. Councilor, D. R. MacGregor.

AUSTRALIA SOUTHERN, No. 23: Chairman, B. V. Heath. Secretary, Robert G. Miller, 22 Cooloongatta Road, Camberwell E 6, Vic., Australia. Councilor, K. T. H. Farrer.

AK-SAR-BEN No. 24: Chairman, D. Robinson. Secretary, J. L. Myers, Meat Inspection Div., U.S.D.A., 5001 Lafayette Ave., Omaha, Nebr. Councilor, R. P. Joslin.

HAWAIIAN, No. 25: Chairman, G. L. Pickering. Secretary, Morton Nemiroff, Dole Corporation, P.O. Drawer 3380, Honolulu, Hawaii. Councilor, E. Ross.

MEXICO, No. 26: Chairman, R. Illescas Frisbie. Secretary, Herminia Bellato, Lab. Nacionales de Fomento Ind., Apartado Postal No. 23537, Mexico 10, D. F., Mex. Councilor, C. J. Horney.

WISCONSIN, No. 27: Chairman, R. Maas. Secretary, Maria Burger, 2225 Eton Ridge, Madison 5, Wis. Councilor, R. B. Kocher.

MINNESOTA, No. 28: Chairman, H. E. Bauman. Secretary, Shirley R. Trantanella, Univ. of Minnesota, Dept. of Hort., St. Paul 1, Minn. Councilor, J. F. Wintermantel.

KANSAS CITY, No. 29: Chairman, J. M. Gorman. Secretary, Edward E. Chapman, Doty Technical Laboratory, 1435 Clay St., North Kansas City 16, Mo. Councilor, A. E. Stevenson.

JAPAN, No. 30: Chairman, T. Obara. Secretary, Masao Fujimaki, Tokyo Univ., Faculty of Agr., Hongo, Tokyo, Japan. Councilor, S. Iwadare.

WASHINGTON, No. 31: Chairman, A. Kramer. Secretary, James W. Bell, National Canners Assn., 1133-20th St., N.W., Washington 6, D. C. Councilor, W. L. Sulzbacher.

ROCKY MOUNTAIN, No. 32: Chairman, R. L. Horst. Secretary, Max Jonke, The Colorado Milling & Elevator Co., 620 Equitable Bldg., Denver 1, Colo. Councilor, E. H. Hungerford.

BLUEGRASS, No. 33: Chairman, G. R. Jackson. Secretary, Betty J. Swain, Hirsch Bros. & Co., Inc., Pickledilly Sta., Louisville 13, Ky. Councilor, H. W. Putnam.

GULF COAST, No. 34: Chairman, H. J. Deobald. Secretary, Theodore Dennery, P. O. Box 10094, New Orleans 21, La. Councilor, E. A. Fieger.

LONGHORN, No. 35: Chairman, C. J. Harrer. Secretary, Nell Morris, The Frito Co., Exchange Bank Bldg., Dallas 35, Texas. Councilor, W. F. Massmann, Jr.

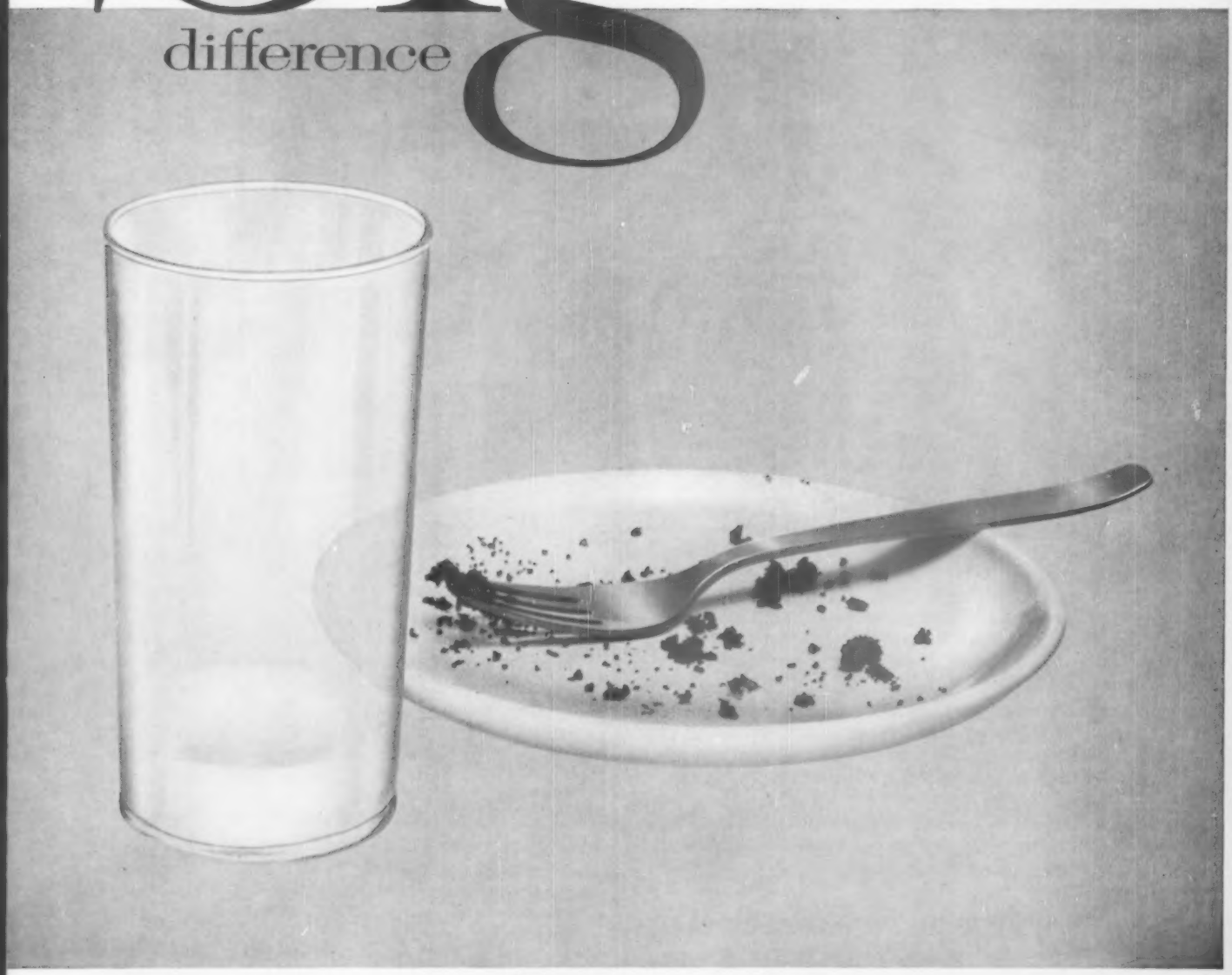
MEMBERSHIP

Write to nearest regional secretary if within an area covered by a regional section, or to the Executive Secretary of the Institute for an application form and information regarding qualifications and classifications.

a little cmc makes a big difference

It looked tasty in the bakery—it lived up to its looks at home. That's why it disappeared fast. And a little Hercules Cellulose Gum, purified CMC, made the big difference. But even if the cake had lasted longer, the icing—and the cake itself—would have remained fresh and tasty, because they both contain a little cellulose gum. It makes a big difference in icings. It prevents "weeping" and also retards crystal growth, keeping the icing surface smooth and velvety. For real "frosting on the cake," see the difference a little cellulose gum can make.

For complete details write to Hercules.



Hercules® Cellulose Gum

VC61-3

HERCULES POWDER COMPANY
INCORPORATED
Hercules Tower, 910 Market Street, Wilmington 99, Delaware

by the Nutrition Foundation, Inc., administered by the IFT, and consists of a $1,000 honorarium and an engrossed plaque.

Dr. Mrak has a keen interest in basic research in the ecology and taxonomy of yeasts, and is one of the world authorities on classification of these microorganisms. Many he has studied are naturally associated with fruits, and he has been concerned with the effects of various food processing techniques on the activity of these organisms, which has led to a wealth of new knowledge.

Since joining the staff of the University of California in 1936, Dr. Mrak has carried on research in the preservation of fruits by drying, vitamin retention in processed foods, and the role of various additives in food processing. He is now a member of the Food Protection Committee of the National Research Council.

1961 International Awardee

Maynard A. Joslyn, Professor at the University of California, Berkeley, is the 1961 Institute of Food Technologists International Awardee. This award, consisting of an engraved Silver Salver donated by the Australian Regional Sections of the Institute, is presented to a member of the IFT who has made outstanding efforts in promoting the international exchange of ideas in the field of food technology.

M. A. Joslyn

Dr. Joslyn, who earned his Ph.D. in Chemistry from the University of California, has served continuously on the staff in Berkeley since 1935, with the exception of military service during World War II.

In earning an international reputation, the 1961 Awardee spent several years in Australia during World War II as a specialist in expediting food production and procurement, ending his service with the Army Quartermaster Corps as a Lieutenant Colonel.

In 1959 he visited Israel to investigate and plan food processing, and between 1959 and 1960 visited Zurich, Switzerland to investigate chemistry of protopectin at the Institute of Agricultural Chemistry. During the remainder of 1960, Dr. Joslyn travelled in Italy, France, Holland, England and Scotland to visit centers of food research and food processing plants, ending the year as Visiting Professor of Food Technology at Massachusetts Institute of Technology.

1961 Food Technology Industrial Achievement Award

Swift and Company, for its (ProTen) Process, has been named recipient of the 1961 Food Technology Industrial Achievement Award. Swift's contribution proved to be an outstanding food process representing a significant advance in the application of food technology to food production.

The (ProTen) process has demonstrated that scientific technology can overcome some of the inherent variations of meat raw materials.

The product resulting from the (ProTen) process is a meat carcass containing uniformly distributed levels of papain so designed to produce a tender cooked meat item when subjected to standard cooking temperatures. The ante-mortem injection of the tenderizing enzyme by the (ProTen) technique has not only raised the tenderness level of all grades of cattle but has overshadowed the tenderness variation within a grade.

Goeser

Bernholdt

Reece

Hogan

Beuk

As winner of the Award, Swift was presented a large bronze plaque. Each of the Swift scientists directly involved in making the achievement a success received an engrossed plaque. They are: Mr. Paul A. Goeser, one of the originators of the concept; Mr. Harry F. Bernholdt, who has taken the laboratory concept and put it into commercial application; Dr. William O. Reece, whose knowledge and skill as a veterinarian have been utilized in successfully working out the injection and animal handling techniques; Dr. John M. Hogan, one of the original men who devised the over-all concept of ante-mortem injections utilizing enzymes, and successfully prepared an enzyme solution from papain which makes the process possible; and Mr. Jack F. Beuk, who worked with Dr. Hogan in developing processing and control techniques for the production of the enzyme solution used in the (ProTen) process.

D&O proudly presents THE PERFECT SEASONING . . . the most scientific approach to seasonings, developed at the D&O Dry Materials Division.

PREMIUM QUALITY:

SPISOSEALS

SPISOSEALS are a line of powdered spice flavors based on spray dried oils and oleoresins, precisely formulated for use as alternates for crude spices, essential oils and oleoresins, solubilized oils, and dry solubles. There is no form of seasoning with finer, more well rounded flavor, nor any with such ease of handling.

SPISOSEALS: guaranteed flavor control and instant flavor release. Unsurpassable shelf life: these "locked-in" seasonings by virtue of the impermeability of their structure (tiny globules of oil secured each in its own individual casing) are protected against ravages of time, spoilage, volatilization.

SPISOSEALS: water soluble; completely and uniformly dispersible, both in dry products and in aqueous liquids where emulsion qualities set up a colloidal suspension system assuring permanent dispersion.

SPISOSEALS: stable, will not dry off — proved by analysis. Free from contamination, will never speck or discolor product.

SPISOSEALS may be custom formulated to replace any blend of spice flavors you are now using . . . We invite processors of quality food products to sample this new line of premium quality seasonings. Send your request to D&O Dry Materials Division, 249 Goffle Road, Hawthorne, N. J.

Write for copy of SPISOSEALS brochure

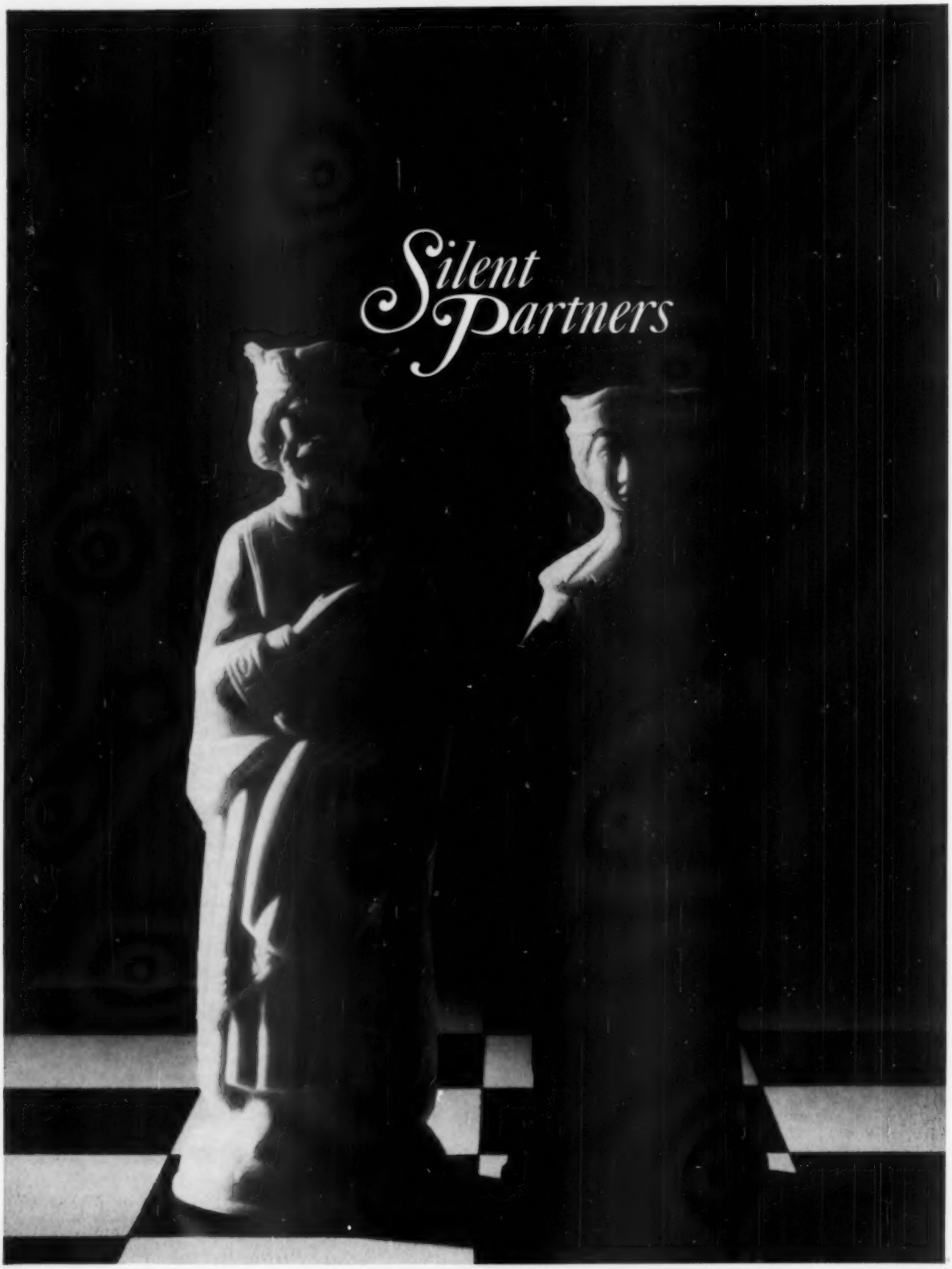
D&O

FLAVOR BASES • ESSENTIAL OILS
AROMATIC CHEMICALS
DRY FLAVORING MATERIALS

Dodge & Olcott Inc.

SEVENTY-FIVE 9TH AVENUE, NEW YORK 11, N.Y.

Sales Offices in Principal Cities OUR 161st YEAR OF SERVICE



America's Leading Firms and Kohnstamm! Many famous corporations consider Kohnstamm a confidential partner in developing or improving products. The same expert counsel in relating flavors or colors to your ideas, is yours for the asking.

SINCE 1851

H. KOHNSTAMM & CO., INC.

First producers of certified colors

161 AVENUE OF THE AMERICAS, NEW YORK 13, NEW YORK

11-13 E. Illinois St., Chicago 11; 2632 E. 54 St., Huntington Pk., Calif.

Some Biological Aspects of Fat Deterioration

C. H. Lea
Low Temperature Station, Cambridge, England

Deteriorative chemical changes in the lipids of foods are likely to be either hydrolytic or oxidative.

HYDROLYSIS

Lipases

Lipases split off the free fatty acids from triglycerides to leave di- or monoglycerides, and ultimately free glycerol. This action can be fairly specific. Pancreatic lipase, for example, removes the α-fatty acid chain from triglycerides much more rapidly than the β-chain, apparently without much regard to the nature of the particular acids involved. And there is evidence that the lipase of milk and some of the microbial lipases may also act in a selective manner.

Phospholipases

A similar action occurs with more complex lipids, such as lecithin, but here, in addition to removal of the α- and β-fatty acid chains, the phosphoryl choline group can also be attacked, in two or three places, each by its own specific enzyme.

An interesting glimpse of the kind of factor that governs enzymic action and specificity is provided by recent work of Bangham and Dawson (1959) on the phospholipase B of *Penicillium notatum*. This enzyme removes the remaining fatty acid from lysolecithin, but will not normally attack pure lecithin. It could, however, be made to act on pure lecithin, by adding to the system certain acidic phospholipids or synthetic detergent-like molecules. It has now been shown (Dawson and Bangham, 1959) that this activation effect is due to penetration of the lecithin micelle by the acidic phospholipid or detergent, producing a net negative charge at the surface. Until this negative charge exceeds a certain minimum level, enzyme-substrate association presumably does not occur and the lecithin is not attacked.

In somewhat similar work, Epstein and Shapiro (1959) showed that the phospholipase of intestinal mucosa will not attack intact lecithin unless free fatty acid is present as an activator.

Activation by freezing

Of particular interest from the viewpoint of food preservation is the activation of lipid-splitting enzymes by freezing. Rimon and Shapiro (1959) recently reported that really fresh ox pancreas is valueless as a source of lecithinase A, but that on storage at $-12°C$ for at least 2 weeks the phospholipase activity appears.

Action in "dry" systems

Fat-splitting enzymes do require a certain amount of water for their action, but the quantity is small and activity can persist at quite a high level in a dehydrated food system. In early experiments of our own (Lea, 1943) on the effect of residual moisture content on the rate of hydrolysis of the fat of dehydrated raw minced beef there was still some lipolytic action at the lowest moisture content reached (1.5%).

Effect of temperature

The rate of hydrolysis of lipids by lipase and phospholipase is, of course, slowed down as the storage temperature is reduced. And there is a further sharp reduction in rate at a temperature just below 0°C, which emphasizes the value of frozen storage.

Effects on quality

Whether or not the liberated fatty acids have any serious effect on flavor depends on their chain length. When no appreciable quantities of fatty acids with fewer than 14 carbon atoms are present, hydrolysis does not produce any catastrophic effect on flavor, though it can be a nuisance in other ways.

But when fatty acids with 12 and fewer carbon atoms are present in quantity, liberation of the free acids by enzyme action can cause "soapy" or "rancid" off flavors. Investigation of "soapy" off flavors in biscuits was recently begun at the Cereals Research Station at St. Albans. (Halton *et al.*, 1959). These flavors have been found to be due to hydrolysis of the coconut oil by flour unusually rich in lipase. The high lipase activity apparently resulted from mold growth on the grain during one of our wet harvests. "Soapy" flavors of this kind seem to be associated mainly with the presence of free capric and lauric acids.

Milk fat, because it contains volatile water-soluble fatty acids combined in its glycerides, readily develops a "rancid" or "bitter" taste on hydrolysis. The bitter taste may perhaps be due to mono- or diglycerides containing butyric acid. Determination of off-flavor thresholds in milk and ice cream after partial hydrolysis by the milk lipase system shows that a rancid flavor can be detected when about 0.5–1% of the fat has been split.

Adverse effects on structure can also be produced by lipolytic activity. Bacterial attack on the phospholipids of the fat-globule membrane of milk, for example, can destroy the membrane structure and cause the emulsion to collapse, with coalescence of the fat globules.

Changes in the lipids of mammalian liver during storage

It is not at present known whether adverse effects on the texture or flavor of meat or fish can result from autolytic decomposition of their lipids. But several groups, including our own, have recently started work in this field (Rhodes and Lea, 1961). We chose mammalian liver as a first foodstuff for investigation,

partly because it is rich in lipids, particularly phospholipids, and partly because the liver is known to be, *in vivo*, the seat of intense metabolic activity.

The lamb livers we used averaged 5.7% of lipid, of which about ⅔ was phospholipid and the remainder mainly triglyceride.

The fall in lipid phosphorus showed the rate at which the fatty acids were being split off from the phospholipid molecules at the various temperatures, and the fall in carboxylic ester value showed the same thing for the lipids as a whole. Comparison of the two sets of data showed that the neutral lipids were being hydrolyzed more rapidly than the phospholipids. Changes were rapid at 37° and 15°, and appreciable at 1°, but changes during 5 months at −10° were too small to be detected above the random scatter due to the variability of the material. There was definite evidence of an activation of the lipolytic enzymes by freezing and storage in the frozen state.

Proteolysis in general followed a very similar pattern to that of the lipid changes. The net result indicated that the hydrolytic enzymes of lamb liver are extremely active at high temperatures but rapidly lose their activity as the temperature is reduced, becoming very slow indeed at −10°C. Tasting tests on the whole bore out these observations.

Changes in the lipids of fish muscle during storage

As cold-blooded animals, fish might perhaps be expected to possess enzymes that retain a greater proportion of their activity at low storage temperatures.

Recent Canadian work (Dyer and Frazer, 1959; Dyer and Morton, 1956) has, in fact, shown that the lipids in the muscle of some fish do hydrolyze to a considerable extent at cold-storage temperatures, the changes being particularly rapid in some of the leaner kinds of fish, such as cod. The fatty acids released come mainly from the phospholipids. A correlation was found between the liberation of free fatty acid on the one hand and deterioration in quality as measured by the taste panel. There was also a correlation with extractability of the actomyosin, and it was suggested that hydrolysis of the lipid of the lipoprotein might perhaps be causing its denaturation.

Olley and Lovern (1960), at the Torry Research Station, have followed the hydrolysis of cod muscle lipids at temperatures from +20° down to −20°. Cod muscle contains only about 0.6% of total lipid, of which about three-quarters is phospholipid. They conclude that hydrolysis of the phospholipids in cod muscle is promoted entirely by tissue enzymes, with negligible roles played by non-enzymic reactions and the bacteria present on iced cod. Freezing strongly activates the lipolytic system, eliminating the initial lag period observed at 0°C. The rate of hydrolysis is therefore nearly as rapid at −14° as at 0°C. Dyer and Frazer (1959) found similar rates of lipolysis at these two widely separated temperatures. The temperature coefficient, however, is about 8 times as great in frozen as in unfrozen fish, and changes are therefore about 10 times as slow at −22° as at −14°C. These observations are in contrast to our own on the lipid changes in lamb liver, where the retardation of rate between 1° and −10°C is so great that the additional benefit of further temperature reduction to −20°C is very limited.

The Scottish workers also noted the similar dependence on temperature of lipid hydrolysis and protein denaturation, but were less inclined to attribute the one phenomenon to the other.

OXIDATION

Each of the several aspects of this subject in which we are interested needs a lecture to itself, and treatment here will have to be very superficial indeed.

The lipoxidases

There has recently been a considerable resurgence of interest in the lipoxidases of vegetable tissues. Tappel and others have measured the relative lipoxidase activity of extracts from various plant sources in terms of soya bean, the richest source known.

Our originally simple views on the nature and action of this enzyme have been shaken recently by the different properties found for enzyme preparations from different plant sources or made from the same source in different ways. According to Koch *et al.* (1958), one constituent of soya lipoxidase attacks only free unsaturated fatty acids and not triglycerides, whereas another, less active, constituent attacks triglycerides more readily than the free acids. This finding links lipoxidase with lipase action, and fits in with several recent observations on food systems. Smith and Andrews (1957), for example, found that the oxygen-absorbing capacity of dough made from stored flours was directly proportional to the free fatty acid content of the flour, and *not* to its total fat content.

In addition to the true lipoxidases, haem-protein catalysts of the cytochrome type are also present in the fat-peroxidizing systems of plant tissues. In most cases their precise nature has not been established.

It has usually been believed that the destruction of carotenoids in vegetable materials results mainly from oxidation by free radicals produced during the chain oxidation of the fats. But Friend (Friend and Mayer, 1959; Friend and Nakayama, 1959) found that oxidative bleaching of the carotene in isolated sugar beet chloroplasts is largely independent of peroxidation of the unsaturated fat present. The fat, in fact, does not oxidize to any extent while the carotene is being attacked. This enzyme or catalyst system that destroys the carotene in damaged plant tissues acts extremely quickly. With a variety of leaves, stems, and pods of green plants, Booth found that one-quarter of the carotene is oxidized within about 13 minutes of maceration of the tissue.

Effect of dietary fat on the stability of carcass fat

Changing again from the vegetable to the animal kingdom we must now consider the effect of diet on the composition and stability toward oxidation of animal fats. This influence of diet can take the form either of a change in the fatty acid composition of

OLAK'S RUTAL ORKS INC., MIDDLETOWN, N.Y.

AMERSFOORT, HOLLAND · PARIS, FRANCE · BREMEN, GERMANY · BRUSSELS, BELGIUM · SOFLOR LTD. - PERIVALE, ENGLAND

MAKE TOUGH CUTS TENDER

ICE CREAM CREAMIER

Improving on nature to make your product a natural...

MEER

Natural Products

SALADS LIVELIER

In natural products, as in so many other fields, it pays to deal with a specialist. Botanicals, gums and resins have been our only business since we opened our doors in 1926. Today, 35 years later, customers know they can count on MEER for expert help, "express" delivery and exceptional products. If you're less than satisfied with your present source . . . if consistent quality lot-after-lot would make your job easier . . . if dependable delivery is a "must" . . . keep MEER in mind. Write for our comprehensive catalog.

MEER CORPORATION

NEW YORK: 318 West 46th St., N.Y. 36, N.Y. JUdson 6-0900
Cable Address: "Merelis", New York

CHICAGO: 325 W. Huron St., Chicago 10, Ill. MIchigan 2-8895

PLANT: 9412 Railroad Avenue, North Bergen, N.J.

CANADA: Witco Chemical Company Canada Limited, Soden Chemicals Division,
2143 St. Patrick Street, Montreal 22, Quebec
41 Advance Road, Toronto 18, Ontario

Meer Corp.

"Natural Products are our only business"

the fat, or of a change in the concentration of natural antioxidants present in the body lipids.

With ruminants the influence of polyunsaturated fatty acids in the dietary fat on the composition of the body and milk fats is limited by hydrogenation in the rumen. But with non-ruminants the changes in the body fat can be very large indeed.

In some more recent experiments of our own (Rhodes, 1958), on the effect of cod-liver oil in the diet on the composition of the lipids of the egg, we found that the average unsaturation, both of the triglyceride fat and of the phospholipids, was increased, but the effect on the phospholipids was much the greater. The average unsaturation of the fatty acids in the β-position of the phosphatidylethanolamine reached the extraordinarily high figure of nearly 5 double bonds per fatty acid molecule, whereas the α-acids still remained mainly saturated, as on the control diet. The hen obviously displays selectivity of a remarkably high order in picking out the highly unsaturated fatty acids from the dietary fat and laying them down in a particular position in the phospholipid molecule.

The adverse effect on stability of the deposition of polyunsaturated fatty acids in the body fat can, of course, be considerable, as shown for turkey meat (Klose *et al.*, 1953). Recent Swedish work (Dahl, 1957) has again stressed the destabilizing effect of feeding fish meal to pigs, and Carlson *et al.* (1957) have shown that whereas a total content of 1.0% of menhaden oil in the diet of broilers causes no significant tainting of the flesh, 1.5% or 2.5% of the oil gives rise to an increasing proportion of complaints of "fishiness" in the roasted meat.

The tocopherols and vitamin E action

Since it was first observed that the tocopherols are able to act as antioxidants for fats, it has seemed possible that vitamin E action might be due to an *in vivo* antioxidant action. According to this theory the vitamin would perform its function by protecting biologically important unsaturated lipids from autoxidative destruction in the living tissues.

Vitamin E deficiency produces many and varied symptoms in different species, and some of these symptoms appear only when the diet contains easily oxidizable polyunsaturated fatty acids. In some of these deficient states, chemical signs of lipid peroxidation *in vivo* can be detected in the tissues. But the most striking argument in favor of the antioxidant theory has been the demonstration that various synthetic antioxidants decrease the requirement for vitamin E, and that various of the symptoms of E deficiency can be prevented or alleviated by chemical antioxidants structurally quite unrelated to the tocopherols.

The principal argument against an antioxidant mechanism has been the fact that no antioxidant was found to perform all of the biological functions of vitamin E. Recently, however, it has been concluded that the requirements of both the chick (Machlin *et al.*, 1959) and the rat (Draper *et al.*, 1958) for vitamin E can be very largely represented by the need for a biologically active antioxidant, and at least one synthetic antioxidant has been claimed to satisfy all the vitamin E requirements of the chick.

Our own interest in the vitamin E field has been mainly in connection with the relative antioxidant activities of the several tocopherols, where a major stumbling block in the way of acceptance of the view that the vitamin E action of the tocopherols is due to antioxidant action has been the fact that biological activity has not paralleled antioxidant activity as determined by *in vitro* experiments.

Relative biological activity varies considerably with the method of assay used, but in general the dimethyl tocols average about 20–40% of the activity of the α-compound, and the monomethyl tocols usually less than 5%. Part at least of these large differences in physiological action of the tocopherols is known to be due to the varying efficiencies with which the several homologs are absorbed from the intestinal tract and deposited in the tissues, the α-compound being transferred more efficiently than the others.

The great mass of the data reported on the literature on the *in vitro* antioxidant activity of the better-known tocopherols, usually determined in lard at about 100°C, have indicated a relative order of activity increasing from α- through β- and γ- to δ, exactly in the opposite order to their biological potencies. Our own results (Lea and Ward, 1959) for lard esters at 90°C confirmed this order, and inserted the newer homologs.

But this is far from being the whole story. When we used a more highly unsaturated substrate it soon became clear that the order of antioxidant activity *could* be reversed, with α- sometimes the best and δ- the worst of the series (Lea, 1960). Conditions that favored a relatively high efficiency of the α- compound were (a) a highly unsaturated substrate, (b) a not-too-high temperature of oxidation, and (c) comparison of activity at a comparatively early stage of the oxidation, before the end of the induction period.

The essential lipids of animal tissues undoubtedly contain polyunsaturated fatty acids, as shown, for example, by recent analyses of the fatty acids of rat liver mitochondria by gas-liquid chromatography (Macfarlane *et al.*, 1960).

Fat peroxides are known to be lethal in very small quantities by injection, although less so when taken by mouth (Holman and Greenberg, 1958; Horgan *et al.*, 1957). It would seem therefore that conditions favorable for a relatively high antioxidant potency of α-tocopherol may well exist in the body tissues, and that the results of experiments with lard at 100° are probably misleading.

However, at least one other factor remains. Haem-protein catalysts, particularly the cytochromes, are known to be present in mitochondria, and may well catalyze oxidation of the lipids.

We are therefore at present comparing the antioxidant activities of several of the tocopherols in model haem-catalyzed emulsion systems, and in liver mitochondria from vitamin E–deficient rats.

Transference of feed antioxidants to animal body, milk, and egg lipids

Since the tocopherols are transferred from the feed of an animal to the body, milk, and egg fats, such transfer would seem to be an excellent way of stabilizing animal fats. But work of Lundberg, Watts, and others has shown that the efficiency of transference of tocopherols from the feed to the body fat is low, and that it falls off rapidly as the amount fed is increased. Nevertheless, attention has again been given to this subject recently, both in Scandinavia and the U.S., and it has been claimed that the palatability of the flesh of chickens receiving fish meal (Laksesvela, 1960) and the keeping properties of frozen pork (Dammers, *et al.*, 1958; Zaehringer *et al.*, 1959) can both be improved by supplementing the feed with tocopherols.

As regards synthetic antioxidants, early experiments on the feeding of phenols such as hydroquinone to rats indicated that transference to the body tissues did not occur, and that there was no increase in stability. Perhaps this was just as well because it would certainly be an embarrassment to obtain stability in this way in countries that do not permit the addition of antioxidants to meat, milk, butter, or eggs.

But DPPD, which can easily be detected in small quantities, has been found in the milk, body, and egg lipids of animals receiving it. Unfortunately, DPPD has also been shown to be quite toxic, particularly to pregnant rats, although chickens apparently tolerate it very much better.

Australian workers demonstrated (Johnson *et al.*, 1958) that both BHA and BHT fed at high levels appear in rat fat, but that the stabilizing effect was not significant at levels likely to be present in feed treated with the antioxidants. At high dietary fat levels BHT (but not BHA) showed increased toxicity for rats, possibly owing to increased absorption from the food (Brown *et al.*, 1959).

French workers (Francois and Piket, 1958) have made the interesting claim that the chicken deposits BHT more efficiently than DPPD, whereas with the pig the reverse is said to be the case. This could indicate a wide species variation in this respect.

Since DPPD is a very effective antioxidant for several purposes in animal feeds, particularly in poultry feeds, Bondi and co-workers (Ascarelli *et al.*, 1960) have been determining the amounts of DPPD laid down in the carcasses and eggs of chickens receiving a treated diet. They find that the maximum level of the antioxidant in the carcass (mainly the body fat and the liver), and in the egg yolk, is reached after only 2 weeks of feeding. After leaving it out of the diet, the stored DPPD practically disappears again within 2 weeks.

The efficiency of transference of the antioxidant to eggs and to milk seems to be about the same, the concentrations of DPPD in the solids of eggs, milk, and body tissues being on the same order of magnitude, very roughly one hundredth of the concentration in the feed.

Reaction of oxidized fat with protein

It is not possible in the time available to say anything on the general question of nutritional damage and possible toxic effects arising from the autoxidation of dietary fats, but only to consider very briefly just one aspect of the subject in which we ourselves have been directly interested—the interaction of oxidized fats with proteins.

Tappel, in 1955, suggested that the brown polymeric substances he obtained when highly unsaturated fat was oxidized in aqueous emulsion in the presence of protein, were due, in part at least, to aldehyde-amine or "browning"-type condensation reactions between fat oxidation products and the protein. Since such reactions would undoubtedly involve the ϵ-amino groups of the lysine side chains, a fall in the biological value of the protein is obviously a possibility.

In later work, however, Venolia and Tappel (1958) and Narayan and Kummerow (1958) came to the conclusion that the insoluble complexes formed between autoxidized fat and protein do not involve covalent bonding, but are due rather to physical adsorption of the oxidized and polymerized fat onto the protein. In this view the protein would not necessarily be damaged nutritionally.

Herring meal contains highly unsaturated readily oxidizable fat, haem-protein catalysts, and protein of high biological value, and it seemed a very suitable material in which to look for such changes.

We used chemical determination of the "available" lysine in the protein by the fluorodinitrobenzene method as a sensitive index of nutritional damage. In brief, we find (Lea *et al.*, 1960) that some destruction of lysine does occur in stored herring meal by reaction of fat oxidation products with the protein, but that the reaction is slow, the loss of lysine amounting to only about 10% during 12 months at ordinary temperatures.

If the meal is allowed to heat up, however, which it will readily do unless its own heat of oxidation is safely dissipated, damage to the protein by this reaction is considerably increased. At still higher temperatures (over 100°C) a second reaction comes in, which destroys lysine more rapidly, and independently of oxidation.

It is interesting to note that at these high temperatures very large amounts of nitrogenous material enter into combination with the lipid and become soluble in lipid solvents. The nature of the chemical reactions involved is not known.

REFERENCES

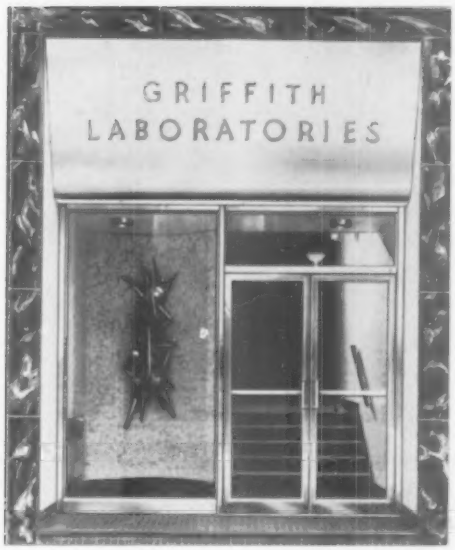
Ascarelli, I., P. Budowski, S. Bornstein, and A. Bondi. 1960. Deposition of N,N′-diphenyl-p-phenylenediamine in chicks and eggs. *J. Sci. Food Agr.* **11**, 509.

Bangham, A. D., and R. M. C. Dawson. 1959. The relation between the activity of a lecithinase and the electrophoretic charge of the substrate. *Biochem. J.* **72**, 486.

Brown, W. D., A. R. Johnson, and M. W. O'Halloran. 1959. The effect of level of dietary fat on the toxicity of phenolic antioxidants. *Australian J. Exptl. Biol.* **37**, 533.

Carlson, D., L. M. Potter, L. D. Matterson, E. P. Singsen, G. L. Gilpin, R. A. Redstrom, and E. H. Dawson. 1957. Palatability of chickens fed diets containing different

PRAGUE POWDER
ANTIOXIDANTS
BREADING MIXES
SOLUBLE SEASONINGS
PURIFIED GROUND SEASONINGS
PURIFIED CEREAL BINDERS
YEASTFOOD
DOUGHNUT SUGARS
MEAT SAUCES
GRAVY BASES
MEAT TENDERIZERS
SOUP BASE SEASONINGS
PHOSPHATES
HYDROLYZED PROTEINS
CASEINATE
PROTEINATE



Where Many find the Answer to — "What's New in Foods?"

The Griffith organization is unique—in its diversification, its laboratory and kitchen facilities and skills.

It is known for its service as specialists . . . in the Art of creating fine food formulas, and in the Science of faithfully repeating them.

If interested in a new food material, or in a new quality standard — you've come to the best qualified source.

THE GRIFFITH LABORATORIES, INC.

CHICAGO 9, 1415 W. 37th St. • UNION, N. J., 835 Rahway Ave. • LOS ANGELES 58, 4900 Gifford Ave.

levels of fish oil or tallow. I. Evaluation by consumer type panel. II. Evaluation by trained panel. *Food Technol.* **11**, 615.

Dahl, O. 1957. Einfluss der Fütterung auf Geschmack, Festigkeit und Haltbarkeit von Schweinefett. Fleischwirtschaft **9**, 331.

Dammers, J., K. Stolk, and G. Van Wieringen. 1958. Importance of Vitamin E for fattening pigs. *Verslag. Landbouwk. Onderzoek.* **64**, 5.

Dawson, R. M. C., and A. D. Bangham. 1959. The activation of surface films of Lecithin by ampipathic molecules. *Biochem. J.*, **72**, 493.

Draper, H. H., S. Goodyear, K. D. Barbee, and B. Connor Johnson. 1958. A study of nutritional role of anti-oxidants in diet of rat. *Brit. J. Nutrition*, **12**, 89.

Dyer, W. J., and D. I. Frazer. 1959. Proteins in fish muscle 13. Lipid hydrolysis. *J. Fisheries Research Board Can.*, **16**, 43.

Dyer, W. J., and M. L. Morton. 1956. Storage of frozen plaice fillets. *J. Fisheries Research Board Can.* **13**, 129–34.

Epstein, B., and B. Shapiro. 1959. Lecithinase and Lysolecithinase of intestinal mucosa. *Biochem. J.* **71**, 615.

Francois, A. C., and A. Piket. 1958. Conference of European Meat Workers, Cambridge, August.

Friend, J., and A. M. Mayer. 1959. The destruction of crocin by isolated chloroplasts. *Biochem. J.* **73**, 18P.

Friend, J., and T. O. M. Nakayama. 1959. Destruction of carotenoids in isolated chloroplasts. *Nature* **184**, B.A.66.

Halton, P., R. A. Knight, H. F. Martin, and F. J. H. Ottoway. 1959. Lipase activity in biscuit doughs. *J. Sci. Food Agr.* **10**, 401.

Holman, R. T., and S. I. Greenberg. 1958. A note on toxicities of methyl oleate peroxide and ethyl linoleate peroxide. *J. Am. Oil Chemists' Soc.* **35**, 707.

Horgan, V. J., J. St. L. Philpot, B. W. Porter, and D. B. Roodyn. 1957. Toxicity of autoxidized squalene and linoleic acid, and of simpler peroxides, in relation to toxicity of radiation. *Biochem. J.* **67**, 551.

Johnson, A. R., M. W. O'Halloran, and F. R. Hewgill. 1958. Phenolic antioxidants and stability of peri-renal rat fat. *J. Am. Oil Chemists' Soc.* **35**, 496.

Klose, A. A., H. L. Hanson, E. P. Mecchi, J. H. Anderson, I. V. Streeter, and H. Lineweaver. 1953. Quality and stability of turkeys as a function of dietary fat. *Poultry Sci.* **32**, 82.

Koch, R. B., B. Stern, and C. G. Ferrari. 1958. Linoleic acid and trilinolein as substrates for soy bean lipoxidase(s). *Arch. Biochem. Biophys.* **78**, 165.

Laksesveln, B. 1960. Supplementation of chick diets with Vitamin E to improve meat quality. *J. Sci. Food. Agr.* **11**, 128.

Lea, C. H. 1943. Dried Meat. V. The storage of dried meat. *J. Soc. Chem. Ind., London* **62**, 200.

Lea, C. H. 1960. On antioxidant activities of tocopherols. II. Influence of substrate, temperature and level of oxidation. *J. Sci. Food Agr.* **11**, 212.

Lea, C. H., and R. J. Ward. 1959. Relative antioxidant activities of the seven tocopherols. *J. Sci. Food Agr.* **10**, 537.

Lea, C. H., L. J. Parr, and K. J. Carpenter. 1960. Chemical and nutritional changes in stored herring meal. 2. *Brit. J. Nutrition* **14**, 91.

Macfarlane, M. G., G. M. Gray, and L. W. Wheeldon. 1960. Fatty acids of phospholipids from mitochondria and microsomes of rat liver. *Biochem. J.* **74**, 43P.

Machlin, L. J., R. S. Gordon, and K. H. Mersky. 1959. The effect of antioxidants on Vitamin E deficiency symptoms and production of liver "peroxide" in the chicken. *J. Nutrition* **67**, 333.

Narayan, K. A., and F. A. Kummerow. 1958. Oxidized fatty acid-protein complexes. *J. Am. Oil Chemists' Soc.* **35**, 52.

Olley, J., and J. A. Lovern. 1960. Changes in the lipids of cod during storage in ice. *J. Sci. Food Agr.* **11**, 644.

Rhodes, D. N. 1958. Phospholipids 5. The effect of cod liver oil in diet on the composition of hen's egg phospholipids. *Biochem. J.* **68**, 380.

Rhodes, D. N., and C. H. Lea. 1961. Enzymic changes in lambs' liver during storage. *J. Sci. Food Agr.* **12**, 211.

Rimon, A., and B. Shapiro. 1959. Properties and specificity of pancreatic phospholipase A. *Biochem. J.* **71**, 620.

Smith, D. E., and J. S. Andrews. 1957. The uptake of oxygen from flour doughs. *Cereal Chem.* **34**, 323.

Tappel, A. L. 1955. Study of mechanism of Vitamin E action. III. *In vitro* copolymerization of oxidized fats with protein. *Arch. Biochem. Biophys.* **54**, 266.

Venolia, A. W., and A. L. Tappel. 1958. Brown-colored copolymers of unsaturated fats. *J. Am. Oil Chemists' Soc.* **35**, 135.

Zaehringer, M. V., S. V. Bring, C. A. Richard, and W. P. Lehrer. 1959. Effect of tocopherol supplementation of swine rations on storage life of frozen pork. *Food Technol.* **13**, 313.

International Food Technology

Fifth Anniversary of Japan Section

Nowhere in the world has the Institute of Food Technologists greater significance than in Japan. Lacking the physical land capacity to produce adequate food supplies for the growing numbers of this industrial-bent nation, Japan has had to look for its subsistence through scientific research and development.

The Japanese section of IFT, with its better than 100 members, is now making plans for its 5th anniversary in Tokyo from August 15 to 16, 1961.

Members of IFT in the U. S. are reminded that much useful information and revelation of challenging problems brought about by limited raw materials production will result from the Tokyo meeting.

Dr. T. Obara, Department of Agricultural Chemistry, Faculty of Agriculture, Tokyo University of Education, Tokyo, is scheduling arrangements for U. S. food scientists to visit Japan for this fifth anniversary meeting.

Poland to Hold International Conference

The Ninth International Conference sponsored by the Polish Scientific Association of Food Technolo-

Highest sensitivity laboratory chromatograph...the New Beckman GC-2A.

The GC-2A employs the most sensitive thermal conductivity detector to be found in any commercially available laboratory gas chromatograph. Extremely stable, full-proportional temperature control over a wide range is combined with a precise carrier gas flow control system to provide exceptionally reproducible retention volumes and peak heights. The 2A functions economically and efficiently in a broad range of applications from routine qualitative analyses to the detection of low, 0.5 ppm. concentrations encountered in trace analyses, and in high efficiency, fast analysis techniques that use small samples. ⌘ An ultra-sensitive Hydrogen Flame Detector, shown above, the new Beckman Stream Splitter for optimizing column efficiency, micro liquid sampling apparatus for highly reproducible samples, and over 100 different standard ¼", and ⅛" packed columns...make this the most versatile of any commercial laboratory gas chromatograph. Consult your Beckman laboratory apparatus dealer. Or write for Data File 84-7-04

Beckman INSTRUMENTS, INC.

SCIENTIFIC AND PROCESS INSTRUMENTS DIVISION Fullerton, California

gists and Technicians, and the Committee of Food Chemistry and Technology of the Polish Academy of Science, will be held in Warsaw, October 25–27.

Theme of the 1961 conference is "Food Technology and Nutritive Value." Papers will cover a wide field of food requirements, diets at different population levels, and the influence of processing methods on the nutritive values of food constituents.

The Polish Association has nine thousand members, representing all phases of the food industry. Its Sections hold regular meetings in their Section-owned buildings. Some one thousand lectures are delivered annually at these meetings.

Twelve scientific and technical journals relating to food science and technology are now published in Poland.

BOOK REVIEWS

PRACTICAL CANNING. Arthur Lock, Food Trade Press, Ltd., London. Second Edition, 1960, viii + 299 pp.

This book is limited to canning operations on fruits and vegetables and is written from the point of view of operations as carried out in the British Isles. The descriptions of procedures and equipment are comprehensive and well presented. The format, printing, and illustrations are excellent.

Although the author disavows any intention of covering the theoretical aspects of canning, it is disappointing to find any book on canning procedures that does not stress the reasons for using high-temperateure steam-pressure sterilizing processes for low-acid canned foods as a means of protecting public health. The thermal processes quoted in the book appear to be satisfactory, and the chapter on Retort Operation is generally satisfactory. The bold-faced type statement on page 134, **"Under no consideration should steam be brought into the retort from the top,"** may be challenged. The introduction of steam from the top of the retort has been found to be quite satisfactory if the retort is piped with proper bottom vents and drains. This procedure has some theoretical advantage because the cold air may be vented from the bottom with less admixture with steam than from the inverse piping arrngement.

The author makes a strong case for clinched-cover exhausting of cans, especially cans of fruit. Although there may be some merit to this procedure, it has not found favor in North America. A table of colors for fruits and vegetables is shown on page 277. The legality of use of these additives would, of course, have to be checked on an individual basis for the countries where the products are to be packed and sold.

If allowance is made for limitations, such as given above, this book may be recommended as a good source of information on practical canning procedures for fruits and vegetables.

It is interesting to note that the Hydron and the Carvallo hydrostatic sterilizers are discussed and illustrated in the main body of the book with other standard pieces of equipment, whereas the Martin aseptic canning system is covered under the heading "Modern Canning Techniques."

J. M. JACKSON

"DICTIONARY OF NUTRITION AND FOOD TECHNOLOGY." A. E. Bender. New York, Academic Press Inc., 1960, pp. vii + 143. Price $5.30.

The intended audience for Dr. Bender's dictionary consists, in his own words, of "medical practitioners, public health workers, home economists, teachers, chemists, and chemical engineers", or, in short, anyone whose interest in food and nutrition is peripheral. And yet it seems that the book might be quite valuable as well to the food technologist and nutritionist as a ready source of information and reference on some 2,000 terms frequently used by them.

The dictionary is selective rather than exhaustive, and in cases where a definition would seem obvious (as under "beef"), the gross chemical and nutrient composition is given instead. This practice, as well as numerous cross references and original literature citations, makes for a very useful volume. Its publication is timely since it does not duplicate in content or purpose any known reference work. The over-all quality of the book seems to be especially good; its format is attractive, its printing is free of errors, and its general high quality indicates that care was exercised in its preparation. In addition to recommending it to specialists whose interest in foods and nutrition is marginal, the book could also be a useful addition to the bookshelf of any food technologist or biochemist, especially one whose work involves scientific writing, documentation, or communication with the lay public.

KATHRYN TORGESON
General Food Corporation

PRESERVATION OF FRUITS AND VEGETABLES. Girdhari Lal, G. S. Siddappa, and G. L. Tandon. Published by the Indian Council of Agricultural Research, New Delhi, India.

The authors are all associated with the well-known Central Food Technological Research Institute at Mysore. The book gives practical guidance in the canning and bottling of fruits and vegetables as this field relates to the development of horticulture under the Five Year Plan in India.

Processes already widely used in India are described, and additional information is given on fruits and vegetables found in India but not commonly preserved in the country.

It also contains a comprehensive chapter on commercial canning, including consideration of the location of the factory, water supply, quality of raw materials, pretreatments, processing. There are descriptive chapters on container, on syrups and brines, and on spoilage in canned foods.

Fruit drinks are very popular in India, and there is extensive and useful information on preparing

CONTROL SPOILAGE LOSSES WITH NEW DOW CHELATING AGENT

A NEW APPROACH to problems caused by trace metal ions in food is now available. Versene® CA chelating agent is calcium EDTA (calcium disodium ethylenediaminetetraacetate dihydrate)—a product developed specifically for the food industry. It chemically inactivates troublesome metal ions such as iron, copper and nickel. Such ions, unless controlled, can cause formation of undesirable precipitates and complexes and catalyze oxidative degradation.

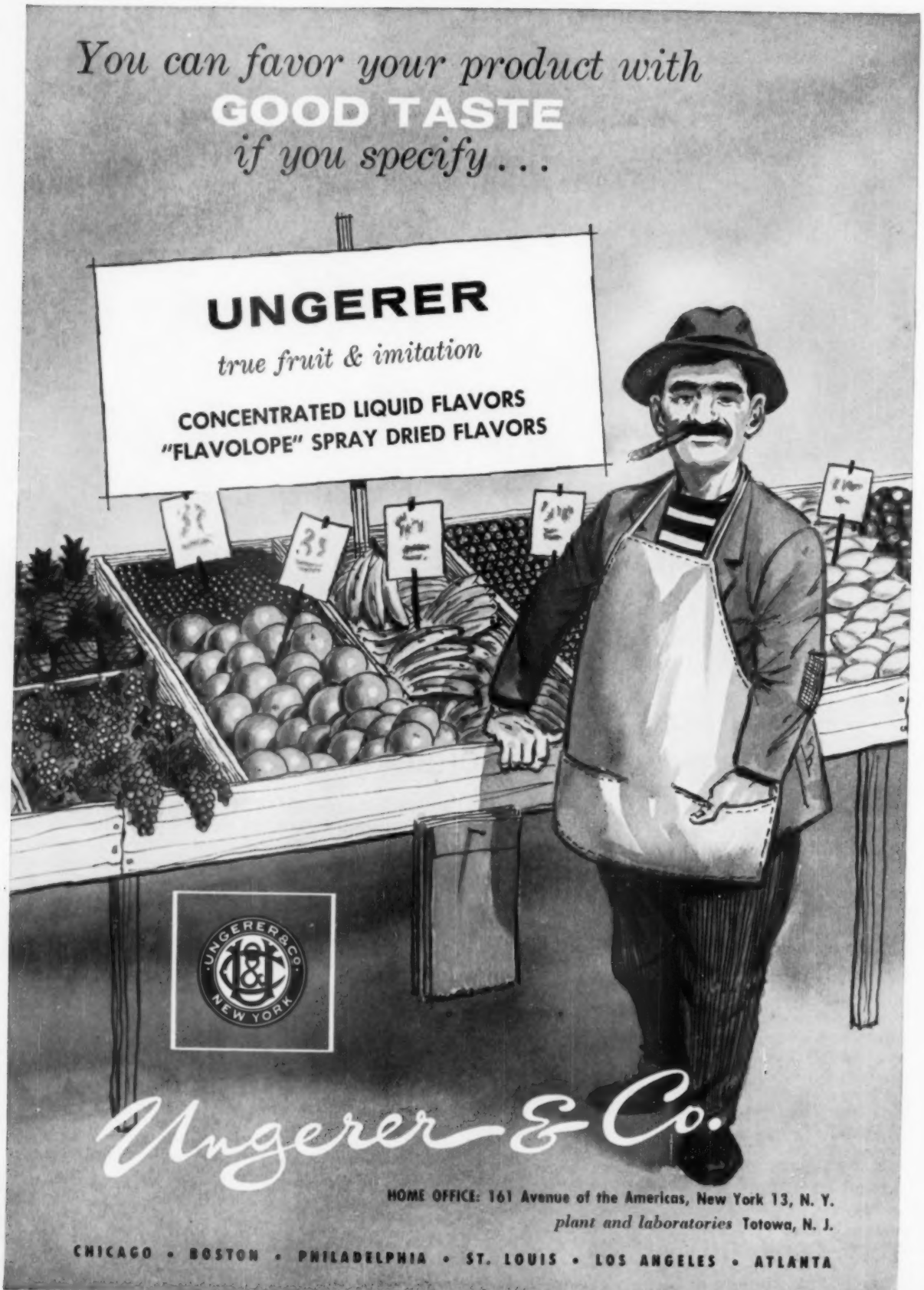
UNWANTED PRECIPITATES AND COMPLEXES are widely encountered in food products. Insoluble, needle-like struvite crystals frequently form in canned seafood, decreasing customer acceptance. Complexes of heavy metals appear to be a cause of "gushing" or "wildness" in beer and cloudiness and sedimentation in wine. Versene CA chelating agent solves both these problems. In addition, it may be utilized to eliminate the undesirable blackening caused in cauliflower, asparagus, and potatoes by iron complexes.

RETARDATION OF OXIDATION with Versene CA is an excellent method for stabilizing flavors and odors and thus extending the shelf life of food products based on fats and oils. Inactivation of metal ions not only eliminates the catalytic effect of the ions on the oxidative process, but also enhances the effect of anti-oxidants such as ascorbic acid. Versene CA has been shown to eliminate the white ring which commonly forms on the surface of French dressing during storage. Retardation of oxidation extends the shelf life of mayonnaise, salad dressing, margarine, nutmeats, and similar products.

FDA REGULATIONS on the use of Versene CA in sandwich spreads, malt beverages, salad dressing, French dressing, mayonnaise, oleomargarine, potato salad, canned shrimp, canned crabmeat, and in non-standardized sauces and dressings were published in the January 5 and April 4, 1961, issues of the FEDERAL REGISTER. Regulations on other products mentioned have not been obtained.

FOR FURTHER INFORMATION and samples write Technical Service and Development, THE DOW CHEMICAL COMPANY, Midland, Michigan, Department 851KD7.

THE DOW CHEMICAL COMPANY DOW Midland, Michigan


You can favor your product with
GOOD TASTE
if you specify . . .
UNGERER
true fruit & imitation
CONCENTRATED LIQUID FLAVORS
"FLAVOLOPE" SPRAY DRIED FLAVORS
UNGERER & CO. NEW YORK
Ungerer & Co.
HOME OFFICE: 161 Avenue of the Americas, New York 13, N. Y.
plant and laboratories Totowa, N. J.
CHICAGO • BOSTON • PHILADELPHIA • ST. LOUIS • LOS ANGELES • ATLANTA

fruit juices and fruit beverages. Also included are relatively detailed chapters on jams, jellies, preserves, chutneys, sauces, and pickles. The production and use of vinegar for the latter group of products is discussed rather more extensively than seems necessary for this type of book.

A short but significant chapter covers the sun-drying and dehydration of fruits and vegetables.

The final chapters cover the manufacture of by-products, particularly pectin, and give consideration to permitted food colors and preservatives for processed products. In addition the Fruit Products Order of 1955 is included as an appendix.

There is also an appendix with the usual reference tables pertinent to food preservation, as well as an extensive bibliography, with 261 references.

In summary a very useful book, especially for tropical countries.

A. G. VAN VEEN

FATS AND OILS. AN OUTLINE OF THEIR CHEMISTRY AND TECHNOLOGY. By H. G. Kirschenbauer, 2nd Edition, Reinhold Publishing Corp., 1960, 240 p.

This book is written for the nontechnical, as well as technical, man who needs a brief understandable reference in the field of industrial fats and oils with an over-all view of the fundamental chemistry and technology of fats and oils.

The first five chapters—dealing with constituents and components, structure and composition of fats, physical and chemical properties, and analytical methods—are valuable primarily as a review for those already having sufficient technical background. The extreme condensation of the material might limit the usefulness of this section for the nontechnical man without further study of basic information. For more detailed information, there are up-to-date references after each chapter as well as a listing of important books in the appendix. The chapter on "Analytical Methods" does not describe gas liquid partition, thin film, and paper chromatographic procedures, which are extensively used today.

Industrial aspects of fats and oils are given particular emphasis in a chapter composing more than half of the book. Hydrogenation, fat splitting, sulfonation, distillation, edible fats, soaps, detergents, protective coating, and lubricants are discussed in concise outline form. The clarity of the flow diagrams of the various processes, as well as the simplified compact organization of the information, makes this section particularly effective. However, only passing mention is made of stabilization, which is an important part of the technology of fats and oils.

The last two chapters, "Some Important Fats" and "Waxes," briefly describe the sources, method of production, and uses for the most common commercially important fats, oils, and waxes. At the end of the book are three rather complete appendices. The first compiles information in tables and charts on composition, distribution, production, uses, and consumption of fats and oils; the second is a detailed glossary of terms, with literature references; and the third is a list of source books.

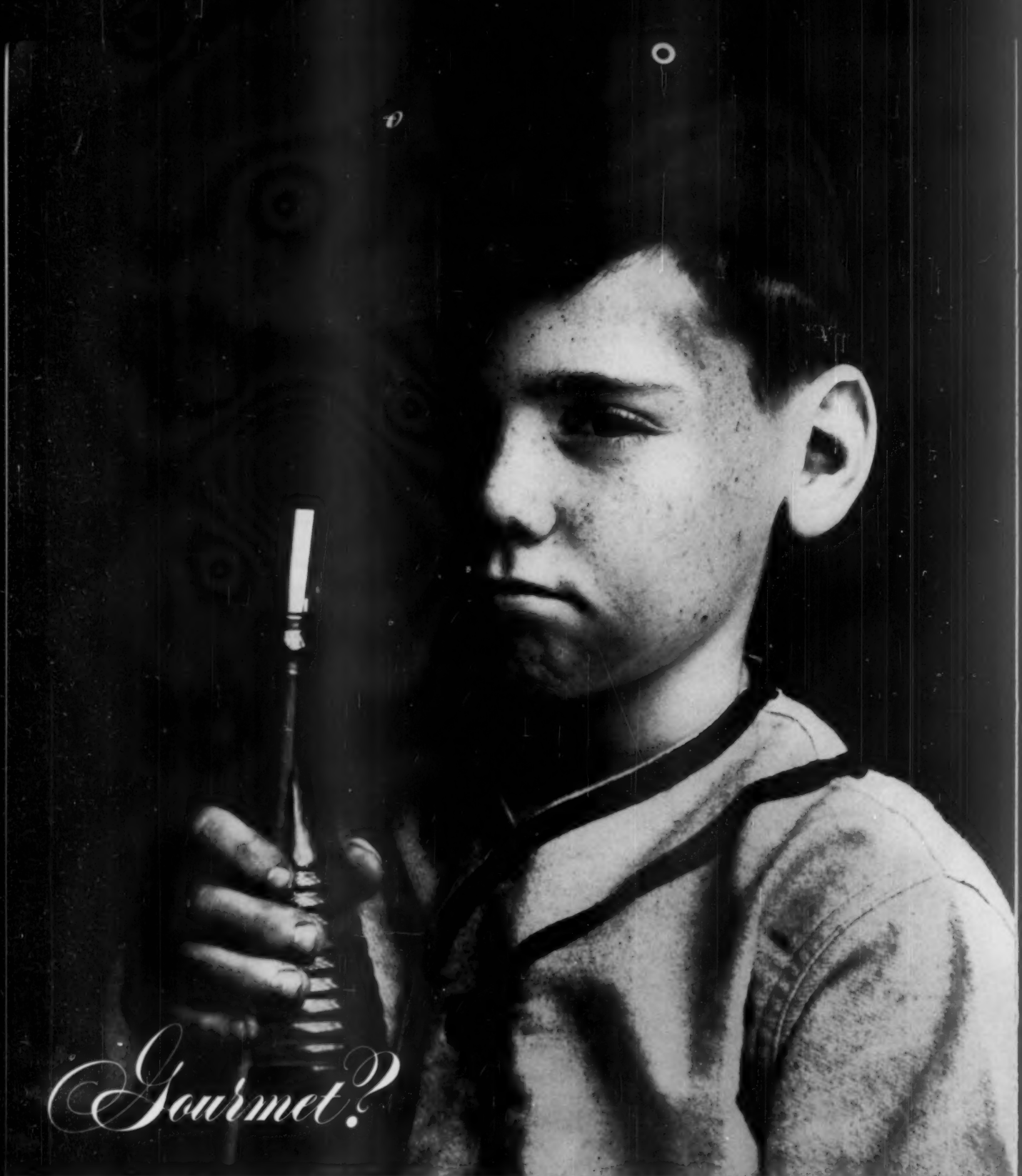
It is difficult to condense such a broad field as fats and oils into a brief outline without oversimplification for the technical man and loss of clarity for the nontechnical man. For this reason, this book does not completely succeed in its purpose as a general reference for nontechnical people. However, for the technical man starting out in the field and for the nontechnical man in a related field, it should provide a useful over-all view of fats and oils.

IRVING RUSOFF

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1961	
July 10–14	National Food Distributors Association, New York City
Sept. 5–8	11th National Chemical Exposition, International Amphitheatre, Chicago, Illinois
Sept. 11–13	Symposium on Foods: Oxidative Deterioration of Food Lipids. Oregon State University, Corvallis
Sept. 11–15	16th Annual ISA Instrument-Automation Conference and Exhibit, Los Angeles, California
Sept. 11–15	Marine Science Instrumentation Symposium, Woods Hole, Massachusetts
Sept. 15–19	American Meat Institute, Palmer House, Chicago, Illinois
Sept. 19–22	Food Science Conference, C.S.I.R.O., North Ryde, N.S.W., Australia
Sept. 19–27	International Conference on Fish in Nutrition, Washington, D. C.
Sept. 28–30	American Hotel Association, Washington, D. C.
Oct. 7–12	Baking Industry Exposition, Convention Hall, Atlantic City
Oct. 15–18	National Association of Food Chains, Palmer House, Chicago, Illinois
Oct. 18–20	National Packaging Forum of Packaging Institute, Biltmore Hotel, New York City
Oct. 23–28	First Inter-American Congress of Chemical Engineering, San Juan, Puerto Rico (write Institute of Chemical Engineers of Puerto Rico, P. O. Box 47, Rio Piedras, Puerto Rico)
Oct. 24–27	American Dietetic Association, Jefferson Hotel, St. Louis
Oct. 28–31	National Automatic Merchandising Assn. Convention and Exhibit, Chicago, Illinois
Nov. 5–8	National Frozen Food Association, Bal Harbour and Americana Hotels, Miami Beach
Nov. 6–10	National Hotel Exposition, Coliseum, New York City
Nov. 12–15	Air Conditioning and Refrigeration Institute, Homestead Hotel, Hot Springs
Nov. 15	British National Association of Wholesale Distributors of Frozen Foods—Annual Lunch, Trocadero, London
Nov. 27–Dec. 1	28th Exposition of Chemical Industries, New York Coliseum
Dec. 1-3	National Automatic Merchandising Assn. Western Conference and Exhibit, Los Angeles, California
1962	
Feb. 9–11	Institute of American Poultry Industries' 33rd Annual Fact Finding Conference; Municipal Auditorium, Kansas City, Missouri
June 10–14	**Twenty-second Annual Meeting of the Institute of Food Technologists, Fontainebleau Hotel, Eden Roc Hotel, Miami Beach, Florida**
Sept. 18–21	First International Congress of Food Science & Technology, Imperial College of Science & Technology, London, England

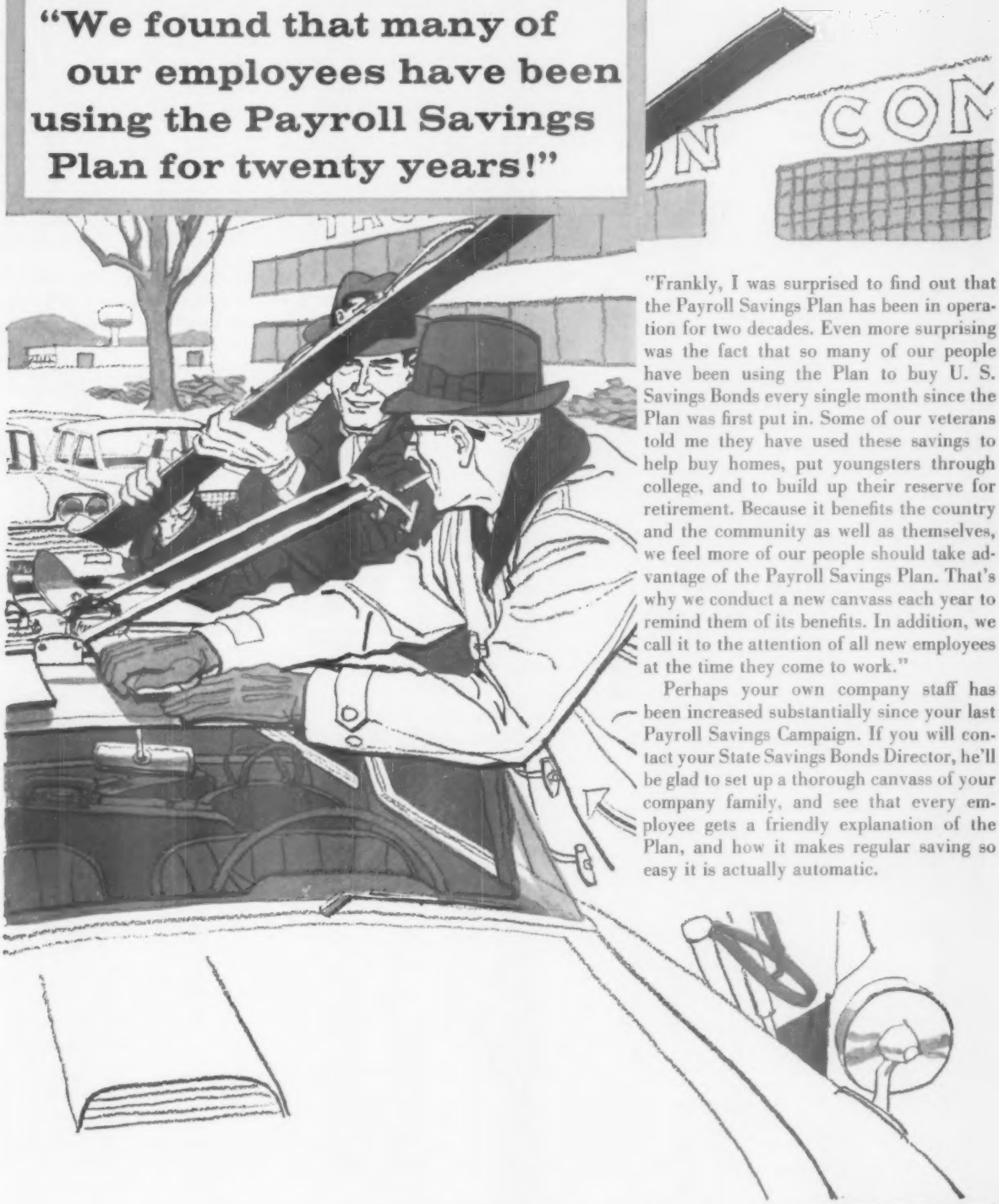
An open invitation is extended to readers of FOOD TECHNOLOGY to send in to the Editorial Office, P. O. Box 164, Davis, California, notices of annual or national meetings of interest to food technologists.



No, But He Knows What He Likes! Caffé Espresso means little in this Little Leaguer's young life. But when it comes to soft drinks, he's a big league consumer! You can't fool him where flavor's concerned. You can't fool the man from Felton, either. If you have a flavor problem — whether you're starting from scratch on a new product or rejuvenating an old one — see the man from Felton. Backed by Felton's more than thirty-eight years of flavor experience, he can help your product achieve the taste that tantalizes, the taste that makes first-time customers all-the-time customers! Felton Chemical Company, Inc., 599 Johnson Avenue, Brooklyn 37, New York.

Felton

"We found that many of our employees have been using the Payroll Savings Plan for twenty years!"



"Frankly, I was surprised to find out that the Payroll Savings Plan has been in operation for two decades. Even more surprising was the fact that so many of our people have been using the Plan to buy U. S. Savings Bonds every single month since the Plan was first put in. Some of our veterans told me they have used these savings to help buy homes, put youngsters through college, and to build up their reserve for retirement. Because it benefits the country and the community as well as themselves, we feel more of our people should take advantage of the Payroll Savings Plan. That's why we conduct a new canvass each year to remind them of its benefits. In addition, we call it to the attention of all new employees at the time they come to work."

Perhaps your own company staff has been increased substantially since your last Payroll Savings Campaign. If you will contact your State Savings Bonds Director, he'll be glad to set up a thorough canvass of your company family, and see that every employee gets a friendly explanation of the Plan, and how it makes regular saving so easy it is actually automatic.

ALL U.S. SAVINGS BONDS—OLD OR NEW—EARN ½% MORE THAN BEFORE

THE U. S. GOVERNMENT DOES NOT PAY FOR THIS ADVERTISEMENT. THE TREASURY DEPARTMENT THANKS, FOR THEIR PATRIOTISM, THE ADVERTISING COUNCIL AND THE DONOR ABOVE.

"A splendid job."
—Food Technology

"So clearly written that it will serve as an explanatory reference for those . . . who have had but little formal education in organic chemistry and the biologic sciences." *—American Journal of Pharmaceutical Education*

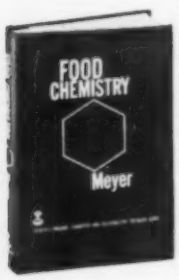
"An excellent integration of the art of food technology with the science of food analysis through the common basis of chemistry."
—Agronomy Journal

Food Chemistry

by LILLIAN H. MEYER

Professor and Head, Department of Chemistry, Western Michigan University

Here is a comprehensive discussion of the chemical composition of foods, and the changes that take place during cooking, canning, pickling, refrigeration and fermentation. Aspects of the technology of food production are considered from a chemical standpoint, and pertinent background material is included. The author also summarizes developments in related fields as they apply to food, and includes a special index listing permissible food additives.



1960
399 pages
$6.75

With today's revolution in methods of food preparation—and the added challenge of the new Food Additives Amendment — this book will prove invaluable to workers in the food industry. *CONTENTS:* Development of Food Chemistry—Fats and Other Lipids—Carbohydrates—Proteins in Foods—The Flavor and Aroma of Food—Meat and Meat Products—Vegetables and Fruits—Milk and Milk Products—Cereals and Their Use—Food Additives—Appendix on Food Additives.

30-DAY FREE TRIAL OFFER
Mail this coupon today

REINHOLD PUBLISHING CORPORATION
Dept. M-839, 430 Park Avenue
New York 22, N.Y.

Send me a copy of Meyer's FOOD CHEMISTRY for *30 days' free trial.*

☐ Purchase price enclosed (Reinhold pays postage)
☐ Bill me (plus postage)
☐ Bill company (plus postage)

Name.....
(PLEASE PRINT)
Address.....
City & Zone..... *State*.....

SAVE MONEY! Enclose $6.75 with order and Reinhold pays all shipping costs. Same return privilege guaranteed. Please add 3% sales tax on N.Y.C. order. *Do not enclose cash!*

News

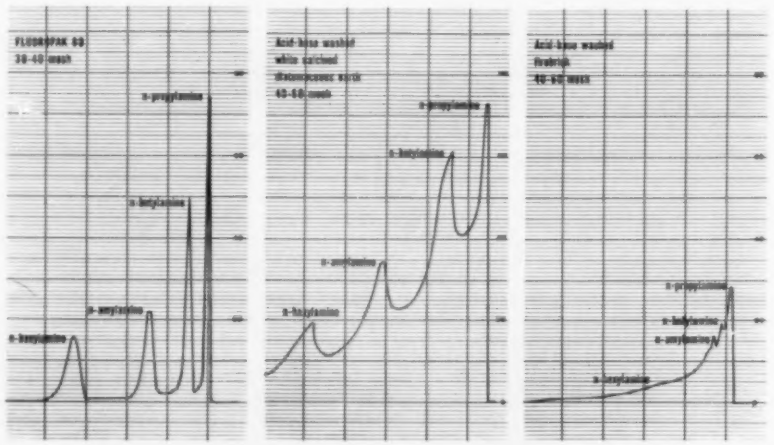
Synflex P-1 is a new line of polyethylene tubing now available from Samuel Moore & Company. Made of the highest molecular weight, low melt index polyethylene resin, P-1 tubing is said to be ideal for air, gas, water and chemical lines—either permanent or temporary hookups where low-cost flexible connections are required. P-1 tubing is unaffected by most chemicals including concentrated hydrochloric, sulphuric, and hydrofluoric acids, according to the manufacturer. Subjected to the ASTM stress corrosion test, it remained unaffected for more than two years, and it is pressure tested during manufacture at 140 pounds presure for 15 minutes. A new descriptive brochure on Synflex P-1 tubing, giving full details, is available from Synflex Products Division, Samuel Moore & Company, Mantua, Ohio.

A newly-developed chromatographic solid support which is said to be completely inert has been introduced by The Fluorocarbon Company, Anaheim, Calif. Marketed under the tradename "Fluoropak 80," the new material is reported to be particularly effective in reducing "tailing" caused by adsorption of highly polar components by active sites on support material.

According to Fluorocarbon officials, a problem of major concern in organic chemical analysis is satisfactory qualitative and quantitative analysis of such highly polar substances as primary, secondary and tertiary amines. The use of typical diatomaceous earth supports in gas chromatographic studies is said to have had limited success due to the presence of residual tailing.

The effectiveness of Fluoropak 80 in reducing tailing is claimed to be particularly significant in the analysis of ammonia, amines, water, hydrogen chloride and other substances exhibiting highly polar characteristics. Its chemically inert properties are reported to make it equally adaptable for highly corrosive substances, such as acetic acid, chlorine, bromine and hydrogen sulfide.

Fluoropak 80 is available in ½ lb and 1 lb packages through leading laboratory supply houses.



DATA COMMON TO ALL THREE CHROMATOGRAMS:

Instrument: standard gas chromatograph with thermal conductivity detector

Column: length – 52", o. d. – ¼"

Stationary phase: 9% Dow Corning 550 Silicone Oil, 1% Carbowax 400

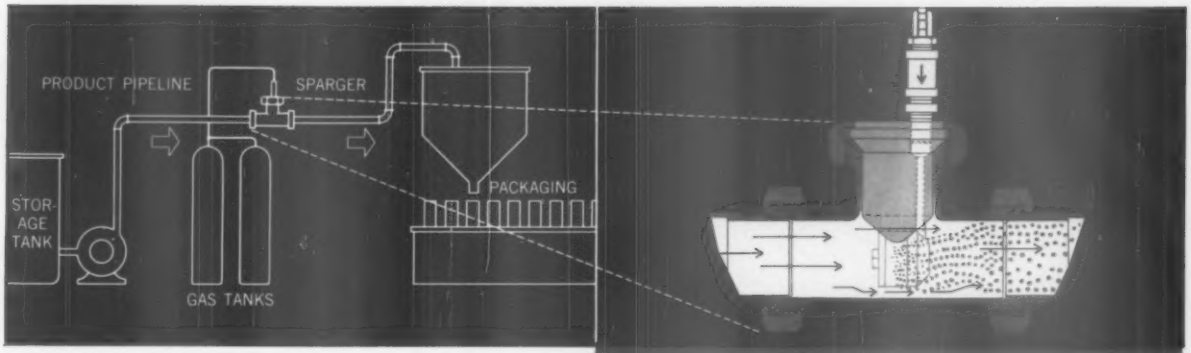
Temperature: 110° C.

Sample size: 2 microliters

Components: n-propylamine – 25%, n-butylamine – 25%, n-amylamine – 25%, n-hexylamine – 25%

Flow rate: 30 mls./min.

Comparison of chromatographic separation of four highly polar primary amines using Fluoropak 80 and two other solid supports.



An exciting new method for — removing oxygen from foods and beverages • fluffing • controlled fermentation of wines • light carbonation of beverages.

Airco gas sparging

EFFICIENT
LOW COST
EASY TO INSTALL

The Airco Gas Sparging process is a new technique of injecting gas into liquid or semi-solid foodstuffs, juices, wines, oils, salad dressing, etc. as they are being processed. Its purpose is either:

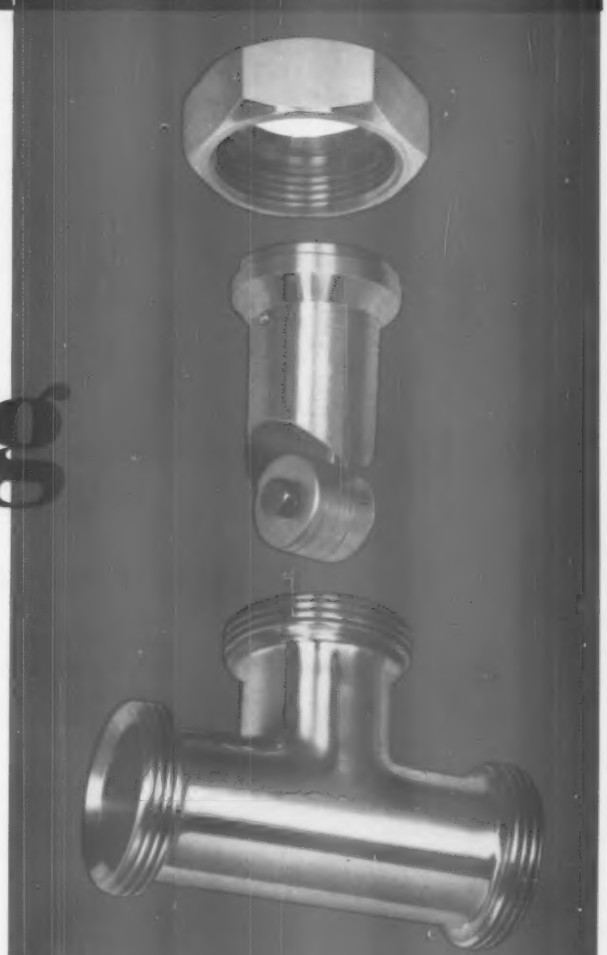
1. To preserve product quality by flushing out oxygen, or
2. To fluff the product by super-saturating it with minute gas bubbles.

Specifically, sparging accomplishes the following: Removal of oxygen from oxygen-sensitive liquids such as citrus juices, edible oils and essential oils, wines, etc. with nitrogen or CO_2. • Fluffing of mayonnaise, salad dressings, shortening, peanut butter, ice cream, etc. with nitrogen. • Controlled fermentation of wines with oxygen, nitrogen, and CO_2. • Light carbonation or effervescence of wines and other beverages with CO_2 or N_2O.

The Unique Airco Gas Sparger:
This clean, simple, compact unit does the job during the process flow with no disturbance of existing equipment. It is easy to install, low in price, efficient.
For further information about Airco Gas Sparging of your products—fill out this coupon—mail it today.

AIRCO®

AIR REDUCTION SALES COMPANY
CUSTOMER SERVICE LABORATORY
1400 East Washington Ave. • Madison 10, Wisconsin



AIR REDUCTION SALES COMPANY
Customer Service Laboratory
1400 East Washington Ave., Madison 10, Wisconsin

Please send complete information on sparging

APPLICATION MOST INTERESTING_____

NAME_____

TITLE_____

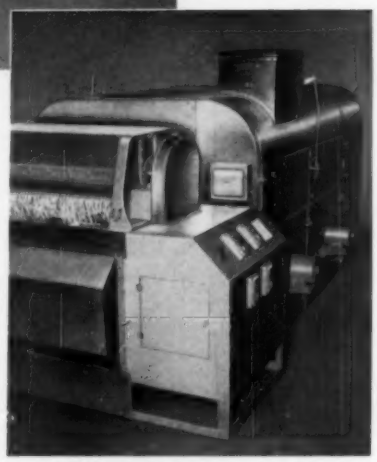
COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

FLEXIBLE FOR LABS — RUGGED FOR PRODUCTION

Sargent single pass pilot plant dryer for lab or production. Each section zoned and controlled independently for widest variation of temperature, humidity.



Single pass dryer with extruder — two drying sections, one cooling section. For pilot plant or production.

DRYERS
by
SARGENT

For Many Food Products

SARGENT'S small to medium size dryers are outstanding examples of the sound economy of "designing and building the machine for the job" in the food industry. These flexible, rugged machines may consist of but two or three drying sections and a feeder (vibrating or standard) — or where required, multiple drying sections plus baking, curing and cooling sections — all in one compact, space-saving, economical machine.

Engineered specifically for pilot plant or moderate volume production, they are easily enlarged by simply adding more drying sections and, where desired, extruders, granulators — even a blow-up section to "fluff" products such as dry breakfast foods during drying.

Because they are designed and built by SARGENT, these rugged moderate-size workers can be depended upon to do a he-man size job on food products and by-products — from milk curd to sliced apples, from cereals to fruits and nuts and coffee.

As with all SARGENT equipment, these new-size dryers are the speediest to erect, the easiest and most economical to clean-out and to maintain of any on the market. Performance is unconditionally guaranteed by us.

Write us your product-drying requirements and let us give you details.

C. G. SARGENT'S SONS CORPORATION
Graniteville, SINCE 1852 Massachusetts

PHILADELPHIA • CINCINNATI • CHARLOTTE • ATLANTA • HOUSTON • DETROIT
NEW YORK • CHICAGO • LOS ANGELES • TORONTO

B. L. Lemke & Co., Inc. announces the availability in commercial quantities of Methylparaben U.S.P and Propylparaben, U.S.P. These preservatives are used in the food and meat industry, in food packaging materials, glues and adhesives, as well as in beverages. For further information and/or a new booklet "Preservatives" which fully outlines the effective concentrations that have been established for a number of food products, write B. L. Lemke & Co., Inc., Lodi, New Jersey.

A new curve follower called the Data-Trak Function Generator, converts manual set-point control to automatic program control, according to Research, Inc., the manufacturer. To place in operation, it is necessary to add a pencil-drawn program curve and connect three wires from the Data-Trak output potentiometer to present circuits. As the instrument stylus follows the program, it turns a control potentiometer. The company also announces that as many as four 3-gang potentiometers may be driven by the same follower mechanism to provide up to 12 separate synchronized control signals. Standard strip-chart recorder paper may be used for the program chart. This facilitates direct (same-scale) comparison with a recording of the programmed variable. Further information is available from Research, Inc., Box 6164, Minneapolis 24, Minnesota.

Expansion News

Ralph K. Gottshall, board chairman and president of Atlas Chemical Industries, Inc. (formerly Atlas Powder Company), announced

that the merger of The Stuart Company with and into Atlas became effective at the close of business May 31, 1961. Stuart manufactures ethical pharmaceuticals at its headquarters in Pasadena, Calif., and distributes them nationally.

A stock split is also effective with the merger. Four shares of Atlas Chemical Industries, Inc. will be exchanged for each share of Atlas Powder Company. Initially, there will be about 3,500,000 shares of the new stock outstanding.

Atlas manufactures polyhydric alcohols, surface-active agents, ethical pharmaceuticals, polyester resins and other materials for the plastics industry, activated carbons, industrial explosives and blasting supplies, and squib-actuated devices used in most of the nation's rockets and missiles. Atlas now has four operating divisions—Chemicals, Explosives, International and Stuart. The Stuart Company corporate name will be retained wherever possible, according to Atlas.

Personnel

Dr. Arthur N. Prater, IFT Treasurer and president of Gentry, a division of Consolidated Foods Corporation, has appointed **Dr. Paul G. Miller** as technical director of the 42-year-old dehydrated seasonings firm. Dr. Miller will be in overall charge of Gentry's research, quality control and technological development programs in the Gilroy and Oxnard, California plants and in the central laboratories in Glendale. Working closely with him will be **F. Leslie Hart,** who continues as technical coordinator. Dr. Miller received his Ph.D. degree in biochemistry from the University of Wisconsin, and his M.S. from the University of Minnesota. His background includes six years on the faculty of Clemson College, South Carolina as a teacher and researcher, assistant research director of the Thomas J. Lipton Company, and research director of Adolph's Food Products Manufacturing Company. Dr. Miller will fill the post vacated by Dr. Prater several years ago when Dr. Prater became president of Gentry.

Paul G. Miller

Wayne Kile, Jr. has joined the food field technical staff of the A. E. Staley Manufacturing Co. as a candy technician, according to an announcement by L. G. Trempel, technical supervisor of industrial sales for the Decatur, Ill., corn, soybean, and chemical processing concern. Kile came to Staley's from the Kroger Co. where he was supervisor of product development for the candy department. A native of West Union, W. Va., Kile graduated from West Virginia Wesleyan College with a B.S. degree in chemistry. As a student he was vice president of Academy of Science and treasurer of Benzene Ring, an honorary chemical society.

Wayne Kile, Jr.

SITUATIONS WANTED

Reply directly to ad BY BOX NUMBER (where indicated) via: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

AVAILABLE: FLAVOR CHEMIST—6 years concentrated experience in duplication and creation of flavors for the food and candy processors, drugmakers, tobacco and beverage industry. Metropolitan New York area preferred. REPLY BOX 865.

FOOD TECHNOLOGIST, M.S. 1948, desires position in technical sales-service or product development. Experience in sales, production management, quality control, and product development with dairy products, drying operations, bacteriology, protein modification, and enzymes; technical writer and inventor of a continuous process. Will relocate for challenging opportunity. REPLY BOX 863.

New M.S. in Food Technology with B.S. in Chemical Engineering desires position in engineering fields related to food processing and product development. Available in September. Salary $7,500. REPLY BOX 870.

Responsible position desired in areas of Technical Sales, Sales Development, Sales Service, or Product Development. 15 yrs. experience with many food products performing above duties. Prefer West Coast. Will discuss other locations. REPLY BOX 871.

AVAILABLE: Food Technologist, B.S. Purdue 1948. Some graduate work. Experience—canning, carbonated beverages and dairy products. Desire Chicago location. REPLY BOX 873.

Food Technologist, M.S. U. S. and Europe educated (dairy, essential oils, sanitation, fermentation), mature. Seeks responsible position with medium sized expanding company. Available soon. REPLY BOX 875.

CHEMIST-FOOD TECHNOLOGIST: Desires responsible, growth position with medium sized company. Offers 18 years diversified, technical experience (research, development, production), managerial experience, initiative and flexibility. REPLY BOX 876.

CHEMICAL ENGINEER-FOOD TECHNOLOGIST: Specialist in Product and Process Research. Mature individual experienced in developing commercially practical products from raw ideas. Backlog of new product ideas in various fields. West Coast location desired. Salary $12,000. REPLY BOX 878.

Recent chemistry graduate desires any position offering the opportunity to assume responsibility. He has worked with many products in quality control and in analytical work. Salary, $6,000. REPLY BOX A-2129.

Chemist with product development and quality control experience desires position as technical director or equivalent in the New York or New Jersey area. Salary, $11,000. REPLY BOX A-2201.

Chemistry and mathematics graduate with broad product experience desires production work within the food industry. Salary, $7,500. REPLY BOX A-2501.

Quality control of hot pack and/or frozen foods interest man with chemistry and bacteriology background. Has also had supervisory and administrative experience. Salary, $9,200. REPLY BOX A-3101.

Young individual with degree in food technology and business administration desires position in food chemistry, new product development, or technical service. Primary experience has been in flavors and colors. Salary, $7,600. REPLY BOX A-3102.

Chemical engineer desires position as director of process engineering. Has had product development experience and prefers to work with prepared mixes. Salary, $15,000. REPLY BOX A-3103.

Food research and/or development position desired by person with several years experience in chemistry within the food industry. Salary, $7,200. REPLY BOX A-0114.

Recent graduate desires production management or quality control position. Has had experience in in-process and sanitation inspections. Salary, $5,500. REPLY BOX A-0115.

Fruits and vegetables interest food technologist with limited experience. Quality control, research in food processing, and product development are the areas of position preference. Salary, $5,000. REPLY BOX A-1121.

Experienced food technologist desires product development, technical service, quality control, or any combination of these positions. Heavy experience in potatoes and french fried foods. Salary, $12,500. REPLY BOX A-1122.

Technical service and product development interest individual with over five years experience in the latter. Area of experience primarily with prepared mixes. REPLY BOX A-1123.

Young individual with experience in food inspection and sanitation desires position in this or technical service area. Has worked with many products. Salary, $7,200. REPLY BOX A-1124.

Recent food technology graduate desires to work with fruits and vegetables as a laboratory or field supervisor. Salary, $5,500. REPLY BOX A-1125.

Young graduate with summer experience desires quality control, production, or technical sales position. Has worked with fruits and vegetables, and dairy products. REPLY BOX A-1126.

Fruits and vegetables comprise area of experience of recent food technology graduate. He desires quality control, technical service or sales position. REPLY BOX A-1127.

Recent food engineering graduate with experience in product development and teaching desires position as process development technologist. Salary, $7,200. REPLY BOX A-1128.

Food technologist with five years experience in product development, production, and quality control, desires position in one of these areas. Would prefer to work with dairy or bakery products. Salary, $9,500. REPLY BOX A-1129.

Technical sales, market development, and production interest recent food technology graduate with experience in corn syrup, canned foods, and cans. Salary, $7,500. REPLLY BOX A-1130.

Food technology graduate with summer experience is interested in technical sales and service position. Salary, $6,000. REPLY BOX A-1131.

Food technologist with over six years experience in quality control desires fruits and vegetables or cereals and baked goods position on the west coast. Salary, $7,200. REPLY BOX A-1402.

Mature chemist with heavy experience in industry and quality control desires supervisory, quality control, or technical service position. REPLY BOX A-2101.

Frozen and dehydrated foods interest food technologist who desires position as project chief, product development. Area of interest also includes production. Salary, $8,500. REPLY BOX A-2102.

Student with summer experience in production and quality control is interested in technical service position. Salary, $6,000. REPLY BOX A-1132.

Technical sales in the southern California area interest man with frozen food and produce experience. Salary, $8,600. REPLY BOX A-1401.

Production management, either overseas or domestic, interests chemist with additional degree in management. He has had eight years experience in plant management and production. Salary, $14,000. REPLY BOX A-2103.

Production and quality control experience in fruits and vegetables comprise background of individual who desires quality control, management or production supervision position. Salary, $10,500. REPLY BOX A-2110.

Pickles and frozen or canned goods interest person seeking management or supervisory position in production or control. Salary, $8,500. REPLY BOX A-2111.

Meats, seasonings, sauces and dressings, and soup bases are products with which person experienced in product development, production, and technical service would like to work. Particularly desires plant manager position. Salary, $14,000. REPLY BOX A-2112.

Chemist experienced in product development, quality control, and administration desires to work with fruits and vegetables. Salary, $9,000. REPLY BOX A-2113.

Production management, product development and quality control each interest individual with experience in these areas. Salary, $11,000. REPLY BOX A-2115.

Chemist with production, product development and quality control experience desires to work with preserves, salad dressings, and syrups as a food chemist or bacteriologist. Salary, $8,500. REPLY BOX A-2116.

Chemist with product development and quality control experience desires to work with confections, syrups, and starches. Desires position as chief chemist, technical director or section head. Salary, $14,500. REPLY BOX A-2118.

Chemist with experience in quality control and technical sales desires position in either of these areas, or as a production supervisor. Product preferences include dehydrated foods, soups, salad dressings, and margarine. Salary, $7,500. REPLY BOX A-2121.

Experienced individual with chemistry background desires to work with beverages, flavors, or confections. Position desired is vice president, assistant to vice president, or general manager. Salary, $19,000. REPLY BOX A-2117.

Fruits and vegetables interest chemist with a desire to work in technical service and/or product development. He has had experience in these areas. Salary, $9,500. REPLY BOX A-2119.

Position as food chemist-technical director interests man with product development, quality control and production experience. Has also worked with can technology. Salary, $9,000. REPLY BOX A-2120.

Biochemist with seventeen years experience in product development and quality control desires position as production manager or general manager. His product preferences include pie fillings, jams, jellies, and fountain toppings. Salary, $15,000. REPLY BOX A-2122.

Experienced chemist desires production, product development or quality control position. Area of experience includes the above as well as spray drying and blending and grinding studies. Salary, $8,500. REPLY BOX A-2123.

Recent graduate desires research or production position working with any food products. Also interested in package development. Salary, $7,000. REPLY BOX A-2124.

Chemist with over ten years experience in product development desires position as plant manager, production manager, or in technical liaison, particularly in the confectionery field. Salary, $12,500. REPLY BOX A-2125.

Product development man with marketing experience desires position as products development manager or package development manager. He is interested in working with condiments and prepared foods. Salary, $17,500. REPLY BOX A-3106.

Young biochemical engineering graduate desires microscopy or engineering position. Engineering constitutes primary area of experience. Salary, $8,400. REPLY BOX A-3107.

Chemical engineer desires position as plant manager or assistant plant manager in the quality control department of spaghetti products. Experience includes fifteen years in quality control. Salary, $15,000. REPLY BOX A-3108.

Recent chemical engineering graduate desires position in product research or cost estimation and evaluation. Primary experience has been in these areas. REPLY BOX A-3109.

Individual with over five years experience in engineering desires position as chemical engineer; this was his major in college. Salary, $9,500. REPLY BOX A-3110.

Chemical engineering graduate with experience in this area desires position in production or as applications engineer. Salary, $10,000. REPLY BOX A-3111.

QUALITY GOES UP

COST COMES DOWN

WHEN YOU SWITCH TO

PENFORD CORN SYRUP

There are so many reasons why you are better off with a liquid corn syrup system... and best off with Penford Corn Syrup! Our technical service representative can prove every point on this quick checklist—and tell you other advantages too:

Penford Corn Syrup is convenient to use, adapts to automation

- *Can be proportioned accurately*
- *Simplifies mixing*
- *Lends itself to automation*
- *Improves plant appearance and sanitation*

Penford Corn Syrup improves the quality of your product

- *Enhances natural flavors*
- *Controls sweetness*
- *Aids in developing body and texture*
- *Stabilizes color*

Penford Corn Syrup saves money over a dry system

- *Reduces cost per hundredweight of sweetener solids*
- *Reduces man hours*
- *Saves handling equipment*
- *Saves with tank storage*

Whether your business is candy, canning, frozen desserts, baking or meat packing—there's a Penford Corn Syrup to suit your needs. Why not let one of our technical representatives come to your plant to demonstrate its advantages from your particular point of view? Call or write any P & F office for prompt action.

Penick & Ford

PENICK & FORD, LTD.
INCORPORATED

750 THIRD AVENUE, NEW YORK 17, N. Y.; 1531 MARIETTA BLVD., ATLANTA, GA.; CEDAR RAPIDS, IOWA; 333 MARKET ST., SAN FRANCISCO 5, CALIF.

POSITIONS AVAILABLE

Reply directly to ads BY BOX NUMBER (where indicated), including the company name of your current employer, via: Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.

Cereal chemist or food technologist—National company has opening for man with experience in baking technology to supervise control bake shop and to conduct experimental work in field of baking. Salary commensurate with training and experience. Write to Dr. J. A. Thorn, Manager of Laboratories, Red Star Yeast and Products Co., P. O. Box 737, Milwaukee 1, Wisconsin.

WANTED: College graduate, major in Chemistry or Food Technology for work in southeastern pickle plant as head of Quality Control and Assistant Plant Manager. Production background preferred, but pickle experience not required. Established company. Reply should include education, age, experience and present salary. BOX 841.

FOOD TECHNOLOGIST/CHEMIST: Position in Quality Control with some Product Development. Knowledge of statistical Quality Control desirable. One or two years experience in poultry, juice, or soup canning also desirable. Midwest location with some travel during seasonal packs. Our employees know of this position. REPLY BOX 879.

AMF HAS AN OPENING
IN FOOD TECHNOLOGY

M.S. or Ph.D. with 5 years' experience in product or process development in Bakery, Dairy, Meat or other food fields. Also do supporting work in food chemistry and food engineering. Must be versatile and capable of assuming responsibility.

Send résumé to
R. H. PARKER
AMF
Research & Development Div.
689 Hope Street
Springdale, Connecticut

WANTED—FOOD CHEMIST. N. Y. City, B.S. 2–3 yrs. experience preferably with some paper and gas chromatography training for general analysis in connection with Product Improvement and Development. Substantial Food Manuf. Co. REPLY BOX 872.

PRODUCTION COORDINATOR
CANNED MEATS

Growing consumer products division of nationally known company has opening in St. Paul and Chicago for Meat Technologist to assist Technical Service Department in coordinating canned meat operation. Position emphasizes Quality Control and provides excellent opportunity for advancement. Salary commensurate with experience and ability.

Degree in Chemistry or Chemical Engineering plus knowledge of production techniques in canned meat operations essential. Age 25–35.

Please send résumé stating education, experience, responsibilities, and salary history. All information will be held in confidence. Interviews will be scheduled promptly. REPLY BOX 877.

FOOD TECHNOLOGISTS
B.S., M.S., Ph.D.

Mead Johnson & Company's continuing rapid growth has created new research positions at all degree levels in the development of nutritional food products.

Development of products meeting high standards of nutrition, acceptance, and stability. Scope of responsibility and salary will depend on experience and training. Liberal employee benefits and relocation allowances. Please send salary requirement and résumé to:

Manager, Technical Employment
Mead, Johnson & Company
Evansville 21, Indiana

Position in food production, research, processing and quality control desired by graduate chemical engineer. Experience covers varied food chemical research, methodology; meat freeze dehydration, pilot plant to production, and chemical control analyses of military rations. Salary $7,500. REPLY BOX 881.

Leading citrus products manufacturer in Florida seeks Food Technologist, Research and Development. Requires applicant who has good technical background with creative ability. REPLY BOX 882.

Eastern Food Canner needs Graduate Chemist or Food Technologist to direct Research and Development program. REPLY BOX 880.

Associate Professor of Food Technology—academic research and teaching responsibilities relating to raw materials and food processing. Excellent facilities and living conditions at a land-grant state college in the Southeast. REPLY BOX 883.

FOOD TECHNOLOGIST/CHEMIST Located near large Eastern city. Job entails Product Development with major vending products manufacturer. Experience should be heavy in flavoring extracts and syrups. REPLY BOX 311, Johnsville, Pa.

Associate Food Technologist-Chemist. Midwest location. B.S. in food or related field and up to four years experience. Will work with Ph.D. in applied research problems involving product formulations. Salary: $6,000. REPLY BOX X-1304.

Food Technologist. Midwest location. B.S. or M.S. in food technology plus experience in food or candy processing required. REPLY BOX X-1305.

Associate Technologist. Eastern location. Up to three years experience in the food industry with emphasis on product and process improvement. B.S. degree required in the area of chemistry, mathematics, or food technology. REPLY BOX X-2202.

Chief Development Engineer. Eastern location. Minimum of B.S., preferably in chemical engineering with knowledge of food technology required of individual with at least five years experience in food or chemical processing, especially evaporation and drying. Will initiate, plan, evaluate and actively lead basic and pilot laboratory studies pertaining to new equipment and/or processes for the food and chemical industries. REPLY BOX X-3201.

Associate or Assistant Editor. Midwest location. Food technology, chemical engineering or related scientific degree desired. Technical editorial staff work as assistant to the Editor in developing article material and preparing it for the printer, describes position. REPLY BOX X-0306.

Senior Food Technologist. Eastern location. Ph.D, M.S. plus five years, or B.S. plus ten years academic or industrial research experience, with major emphasis in the application of scientific knowledge in the development of new or improved products and processes. REPLY BOX X-1206.

Chief Chemist. Eastern location. Bachelor's degree in food technology or chemical engineering required. Experience with mayonnaise and related products or juices and syrups required for this quality control position. Salary: $8,500. REPLY BOX X-1210.

Product Development Food Technologist. Eastern location. B.S. or M.S. with two to eight years experience. Travel to carry out research program in development of food items, improve current items, as well as carry out basic product research on a planned program. Salary: $7,500. REPLY BOX X-1211.

Food Technologist. Eastern location. Degree in food technology or related field; will review and help develop standards for various poultry products, and help develop approved procedures, operations, methods of formulation, etc. REPLY BOX X-1212.

Food Technologist. Midwest location. B.S. or M.S. in food technology or chemical engineering plus some experience with dehydration of foods desirable. Position involves R & D of products and processes in dehydration of meat and other food products. Salary, to $12,000. REPLY BOX X-1302.

Food Technologist. Midwest location. Various types of work in the development and improvement of meat products and processes. Experience preferred, with degree in food technology or chemical engineering. REPLY BOX X-1303.

Food Technologist. Midwest location. Maximum of three years experience plus degree or comparable training in food technology desired of individual who will assist in the working out of formulation and processing problems concerned with the development of specialty food items, and storage and evaluation studies. Salary, $6,300. REPLY BOX X-1317.

Manager, Product Development Laboratory. West coast location. Skills plus degree in food technology are requisites of individual who will head up product development laboratory. Should have strong background in new product development, fruit and vegetable canning, and managerial experience. REPLY BOX X-1403.

Food Technologist. West coast location. B.S. in food technology or related field plus three to five years experience, preferably in product development required. Will be responsible for formulation and development of new canned, frozen, and dehydrated products primarily utilizing fish. Limited travel and rapid promotion anticipated. Salary, $7,800. REPLY BOX X-1404.

Food Technologist. West coast location. Limited experience coupled with B.S. in food technology or related field. Position consists of product development and formulation of all types of fisheries products. Limited travel. Salary, $6,300. REPLY BOX X-1405.

Chemical Engineer. Midwest location. B.S. or M.S. in chemical engineering plus experience in food or candy processing required. REPLY BOX X-3302.

Chemist. Eastern location. Position requires B.S. in chemistry plus at least one year of experience in analytical chemistry, preferably food analysis. Salary, $6,345. REPLY BOX X-2203.

Assistant Chemist. Eastern location. B.S. in chemistry, food technology, or home economics. Flavor, syrup, or canning experience desirable, plus knowledge of touch typing. Quality control analyses and formulation of new products comprise work. Salary, to $5,200. REPLY BOX X-2204.

Foods Chemist. Eastern location. B.S. in chemistry or food technology and up to three years experience required for development work with existing products. Salary, $6,900. REPLY BOX X-2205.

Senior Chemist. Eastern location. Food experience and a minimum of two years analytical chemistry experience preferred, in addition to a B.S. in chemistry. Conduct routine and non-routine analyses of food products; establish new analytical procedures, and evaluate test results. REPLY BOX X-2209.

PROFESSIONAL DIRECTORY

COMPLETE SERVICE . . . for the FOOD INDUSTRY!
Radioactive, Infrared Spectroscopy, Food Additive Studies, Bacteriology. Write for Price List.
SCIENTIFIC ASSOCIATES
3735 Forest Park Avenue
St. Louis 8, Mo. JE. 1-5922

BIOLOGICAL SERVICES
Foods, Drugs, Cosmetics, Chemicals, Feeds, Packaging—Toxicological, Mycological and Bacteriological Investigations
United States Testing Co., Inc.
1415 Park Ave., Hoboken, N. J.

WISCONSIN ALUMNI RESEARCH FOUNDATION
LABORATORY SERVICES
for the FOOD, FEED, DRUG and CHEMICAL INDUSTRIES
Analyses, Biological Evaluation, Toxicity Studies, Insecticide Testing and Screening, Flavor Evaluation.
Project Research and Consultation
Write for Price Schedule
P.O. Box 2217, Madison 1, Wis.

Consultation and Research since 1922
Food and Drug Research Laboratories INCORPORATED
Toxicology
Pharmacology
Nutrition
Biochemistry
Bacteriology
BERNARD L. OSER PH.D.
Director
Maurice Avenue
at 58th St., Maspeth 78
New York City
TWining 4-0800
WHERE EXPERIENCE COUNTS

ENZYMES
and ENZYME Products
Lipase Enzyme preparations from calf, kid goat and lamb animal glandular sources.
Mil-Lait® An enzyme modified whole milk powder for developing a rich, distinctive flavor in milk chocolate, and chocolate coatings, and for emphasizing desirable cheese flavors in dips and sauces.
Write for samples and literature.
DFL
DAIRYLAND FOOD LABORATORIES, INC.
P. O. Box 486, Waukesha, Wisconsin

SPECIALIZED PLACEMENT
Service For Men
In The Field Of
FOOD TECHNOLOGY
Our clients are—National—Our Service—Confidential—rapid—effective
Forward a resumé—or, if you have not prepared one—mail your name and address for further information to
TOM WHITE
DRAKE PERSONNEL, INC.
29 E. Madison Chicago, Ill.
Tel. FI 6-8700

Schwarz®
PROFESSIONAL SERVICES
Since 1869 Schwarz Laboratories has been a leading laboratory and technical service for the food and beverage industries.
We offer thorough, expert advice on food problems of all types, analyses, flavor evaluations, product development, and legal testimony. Costs are low due to our experience and efficient operation and equipment.
May we send you our brochure?
SCHWARZ LABORATORIES INC.
230 Washington St., Mount Vernon, N.Y.
Phone: MO 4-1100 Cable: Swoknip

Advertisers' Index

Air Reduction Sales Company 49
Allied Chemical Corporation 23
*American Can Company 336B, 336C
American Viscose Corporation ..... 56 and 3rd Cover
Beckman Instruments, Inc. 41
Blumenthal Bros. Chocolate Co. 7
Dairyland Food Laboratories, Inc. 55
Distillation Products Industries (Myverol) 11
Distillation Products Industries (Myvacet) 28
Distillation Products Industries 10
Dodge & Olcott, Inc. 31
The Dow Chemical Company 43
Drake Personnel, Inc. 55
Durkee Famous Foods 21
Felton Chemical Company 46
Flavorex Co., Inc. 25
*Florasynth Laboratories, Inc. 336D
Food and Drug Research Laboratories, Inc. 55
*Food & Machinery Chemical Corporation 332B
*Food Materials Corporation 336A
Fritzsche Brothers, Inc. 14
Givaudan Flavors, Inc. 16
The Griffith Laboratories, Inc. 39
Hercules Powder Company 29
Hoffmann-LaRoche, Inc. 2
International Flavors & Fragrances, Inc. ..... 2nd Cover
Kelco Company 4
Klenzade Products, Inc. 17
H. Kohnstamm & Co., Inc. 32
The Meer Corp. 36
Miles Chemical Co. 26, 27
Morton Salt Company 24
Norda ..... 4th Cover
Penick & Ford, Ltd., Inc. 53
Photovolt Corporation 7
Polak's Frutal Works (PFW) 35
Proctor & Schwartz, Inc. 15
Reinhold Publishing Corp. 48
C. G. Sargent's Sons Corp. 50
Schwarz Laboratories, Inc. 55
Scientific Associates 55
Sterwin Chemicals, Inc. 9
Swift & Company 1
S. Twitchell Company 12
Ungerer & Company, Inc. 44
Union Carbide Chemicals Co. 13
U. S. Stoneware Company 19
United States Testing Company 55
*Urschel Laboratories Inc. 340B
*Warner-Jenkinson Manufacturing Company 340A
*R. D. Webb & Co., Inc. 332A
Wisconsin Alumni Research Foundation 55

* Advertisements in Technical Section.

icy treat
icy treat
GARDEN FRESH
GARDEN FRESH
GARDEN FRESH
tea
Marshmallows
Fresh Crisp
POTATO CHIPS
ROLLS
STEAK
icy treat
icy treat

Each food fresh as all outdoors! Flavorful, too...

thanks to various types of AVISCO® CELLOPHANE

Imagine! This wide variety of foods packaged in Avisco cellophane. And no wonder. Cellophane is the *only* packaging film that gives proper protection to *all* these products and *hundreds more*. For cellophane is not merely a single film, but a *family of films*.

There are many different types of Avisco cellophane—each one tailored to meet a *specific* product requirement. For example, fresh meats require an extra-tough film that preserves bloom. Tea demands retention of flavor and aroma. Corn needs a film that breathes. Potato chips need crispness retention. And flavored ices require a special extrusion coated cellophane. There are types of Avisco cellophane for *all* these purposes and *many others*.

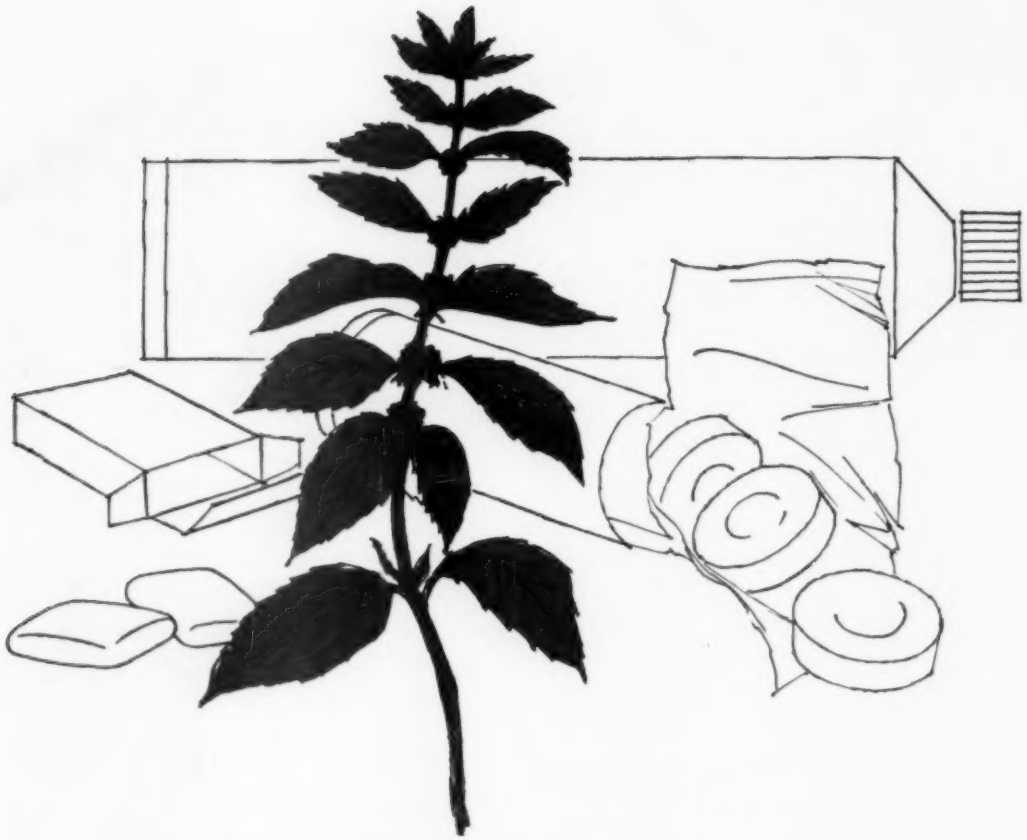
What's more, only cellophane offers the combination of low initial cost, pure transparency and sparkle, superb printability and unmatched performance on packaging machines. The result? *Total packaging economy*.

Get all these benefits in packaging *your* product. Contact us for an appointment with our representative in your area or a selected cellophane converter specializing in your field.

Specify "AVISCO" when you order printed and/or fabricated cellophane from converters.

AVISCO®

AMERICAN VISCOSE CORPORATION, FILM DIVISION,
1617 PENNSYLVANIA BOULEVARD, PHILADELPHIA 3, PA.
SALES OFFICES ALSO LOCATED IN ATLANTA, BOSTON, CHICAGO, DALLAS, LOS ANGELES AND NEW YORK.



When all is said and done...

...NOTHING

TASTES SO TRUE

TO NATURE

Norda®

Flavor it with a favorite

Exclusive Basic Materials for: Candy and Chewing Gum, Dairy Products (Ice Cream and Cheese), Soft Drinks, Desserts (Puddings and Gelatins), Meat Products, Syrups, Bakery Products (Cake Mixes, Crackers, Snack Items), Pharmaceutical Products, Liquors and Cordials.

Write on your letterhead for free samples.

NORDA, 601 W. 26 St., New York 1, N.Y. • Chicago • Los Angeles • San Francisco • Toronto • Montreal • Havana • London • Paris • Grasse • Mexico City